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The British encyclopedia

William Nicholson

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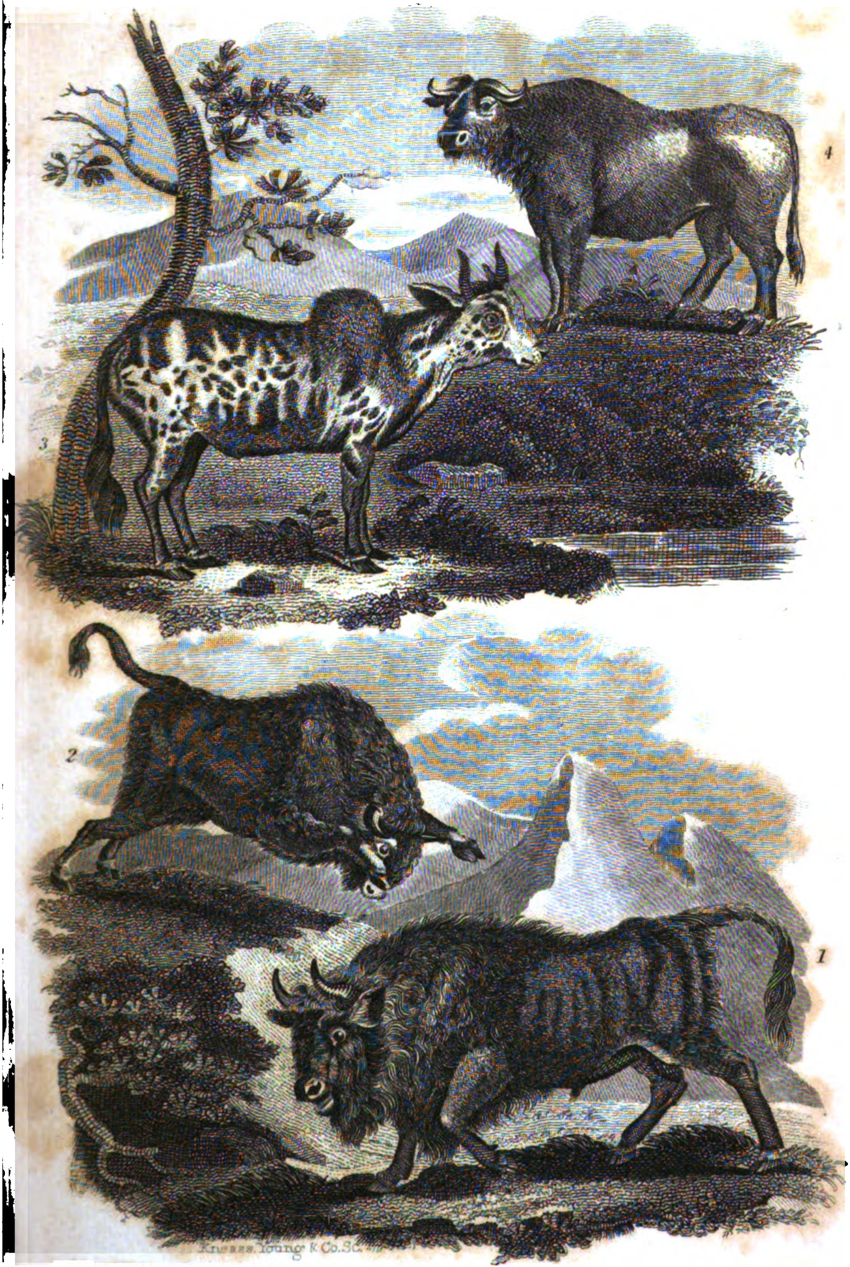

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Fig. 1. Bos taurus: urus or wild bull _ Fig. 2. Bison _ Fig. 3. Zebu _ Fig. 4. **Bos** *bubalus: buffalo.*

MAMMALIA. *Plate II.*

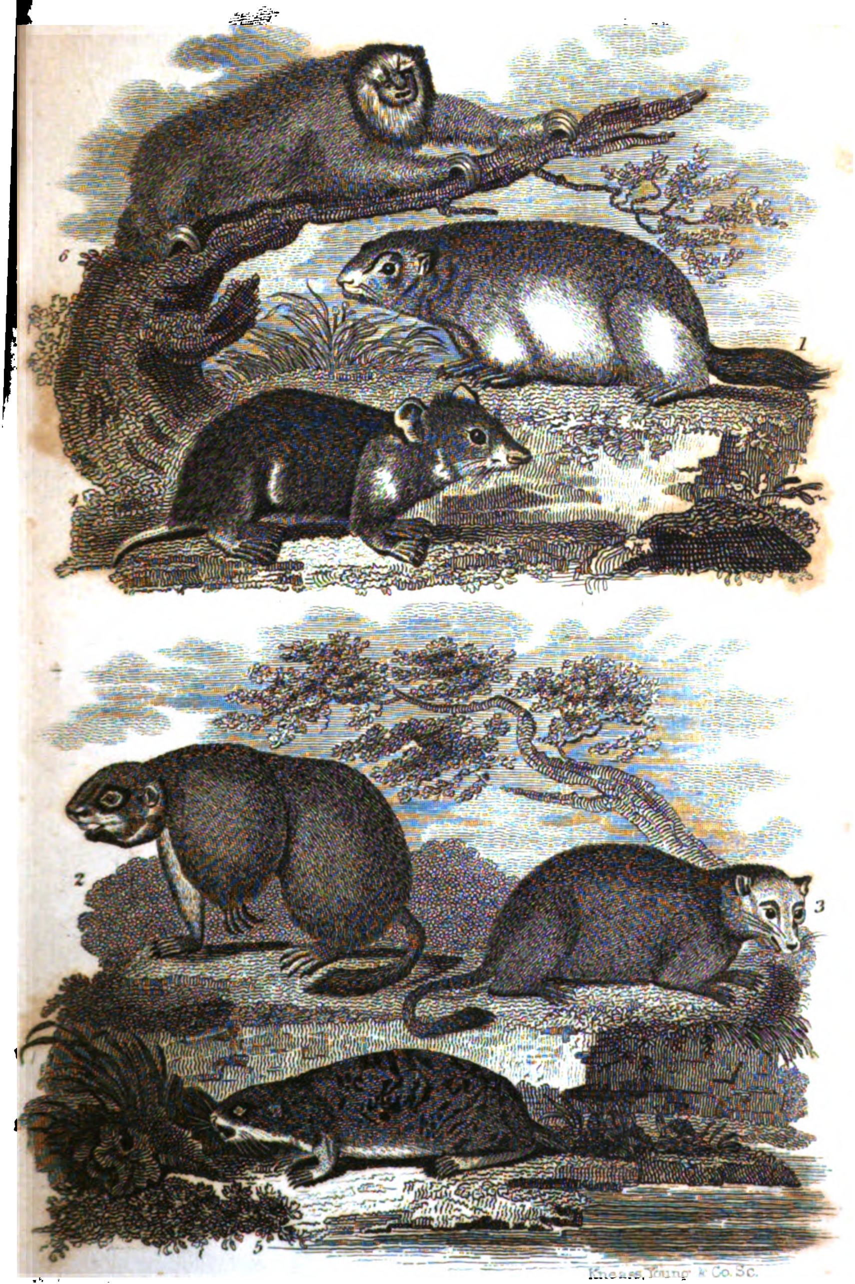

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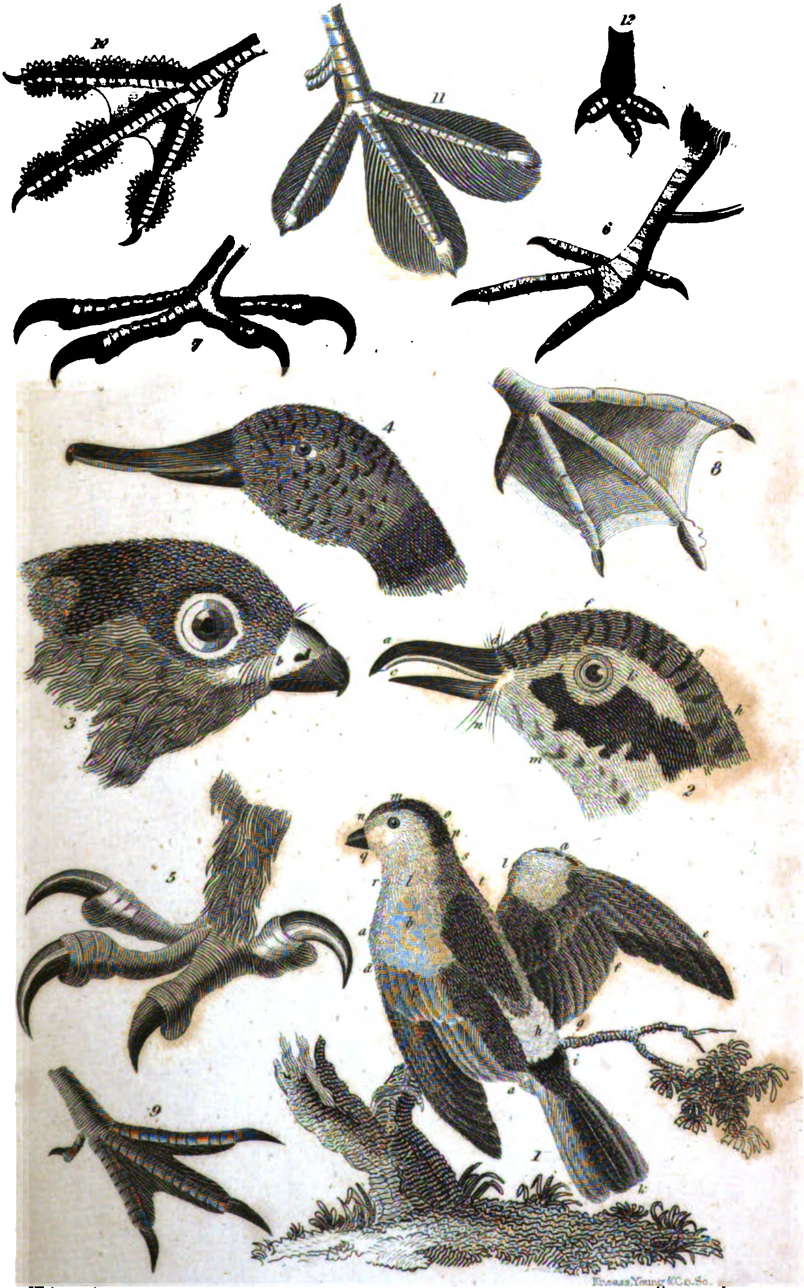
Fig. 1. Arctomys *marmota: Alpine Marmot. Fig. 2. A. empetra: Quebec Marmot. Fig. 3. A. Monax: Maryland Marmot. Fig. 4. Hamster. Fig. 5. Lapland Marmot. Fig. 6.* Bradypus *tridactylus: three toed Sloth.*

AVES.



Explanation of terms used in Ornithology.

See the article
AVES.

AVES.

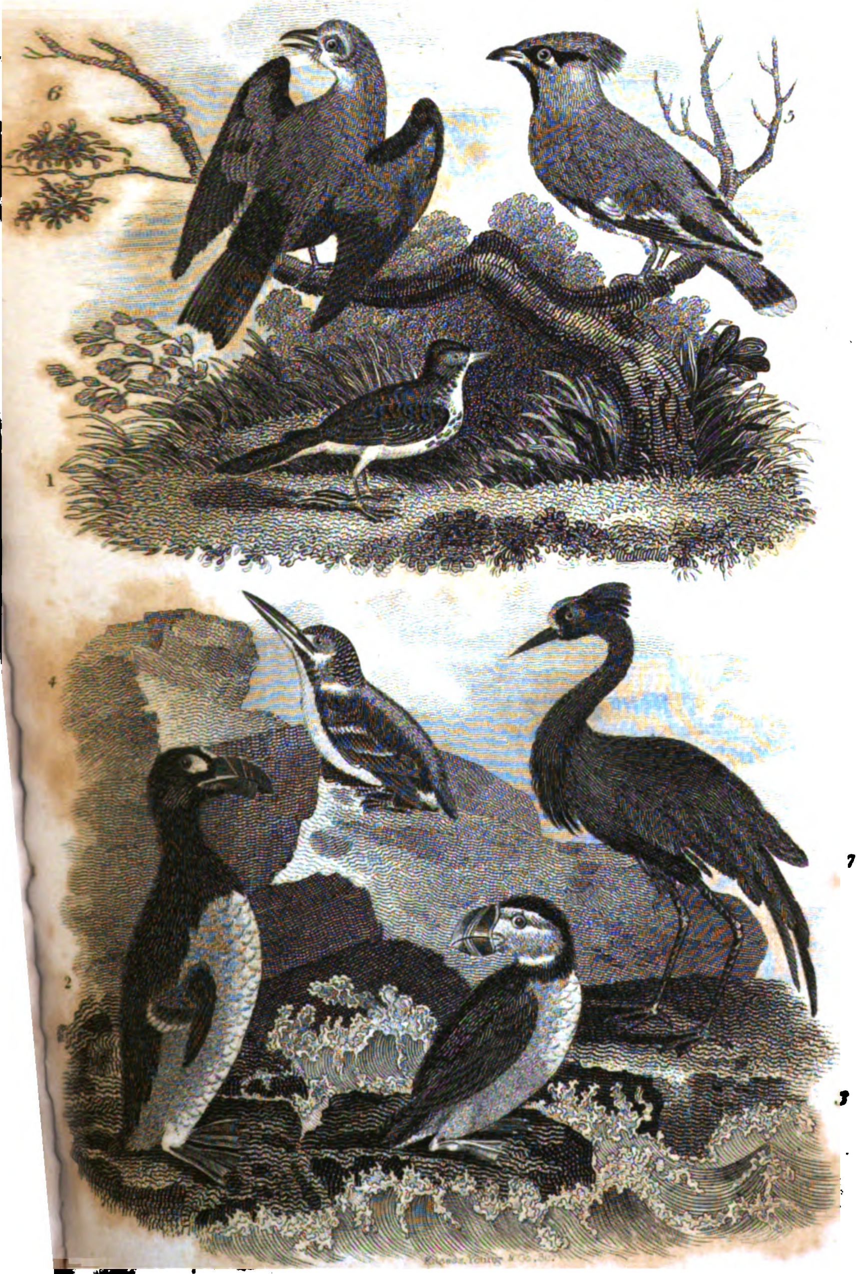


Fig. 1. *Alauda arvensis; Sky lark.*
2. *Alca major; Great Auk.*
3. *Alca arctica; Puffin.*
4. *Alcedo ispida; King-fisher.*
5. *Ampelis garrulus; Waxen chatterer.*
6. *Coracias garrula; Common Roller.*
7. *Ardea virgo; Numidian Crane.*

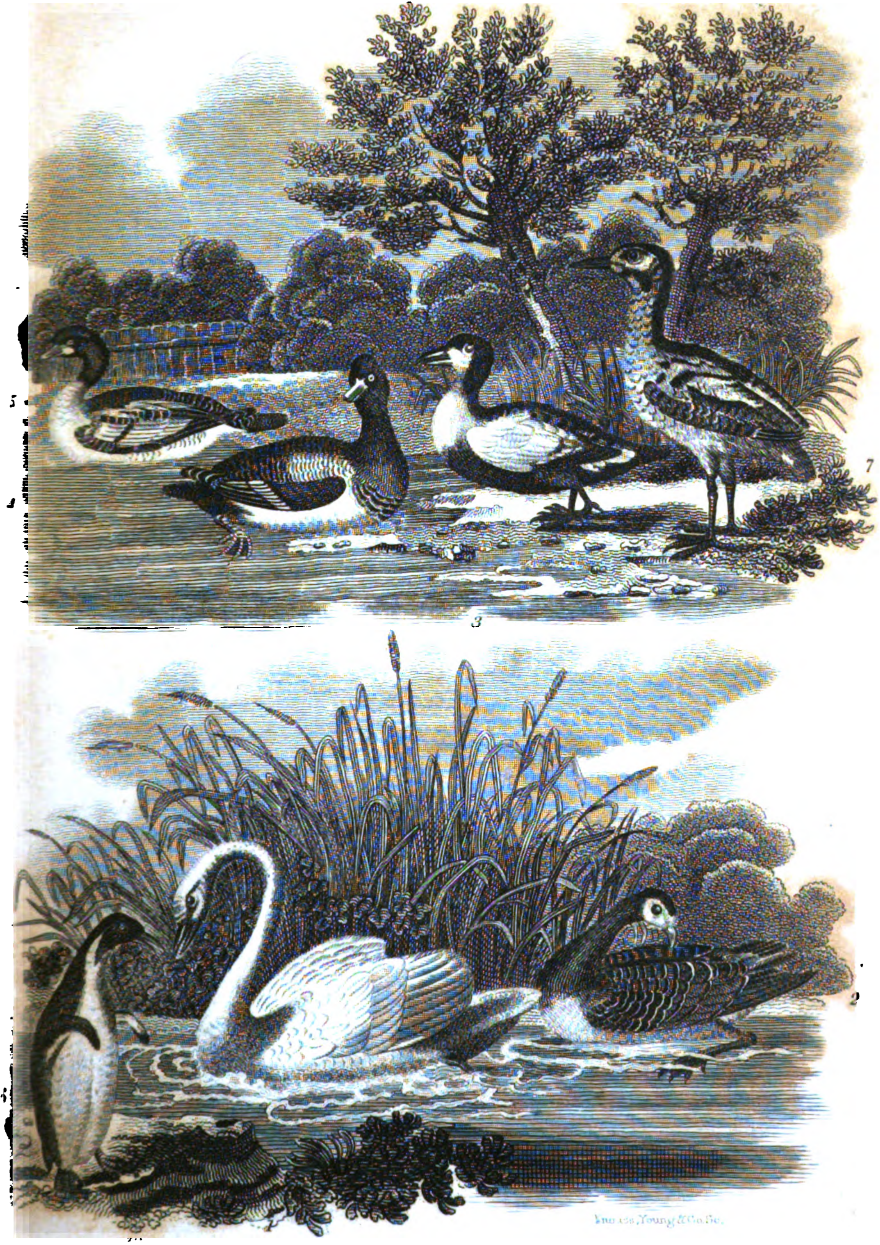
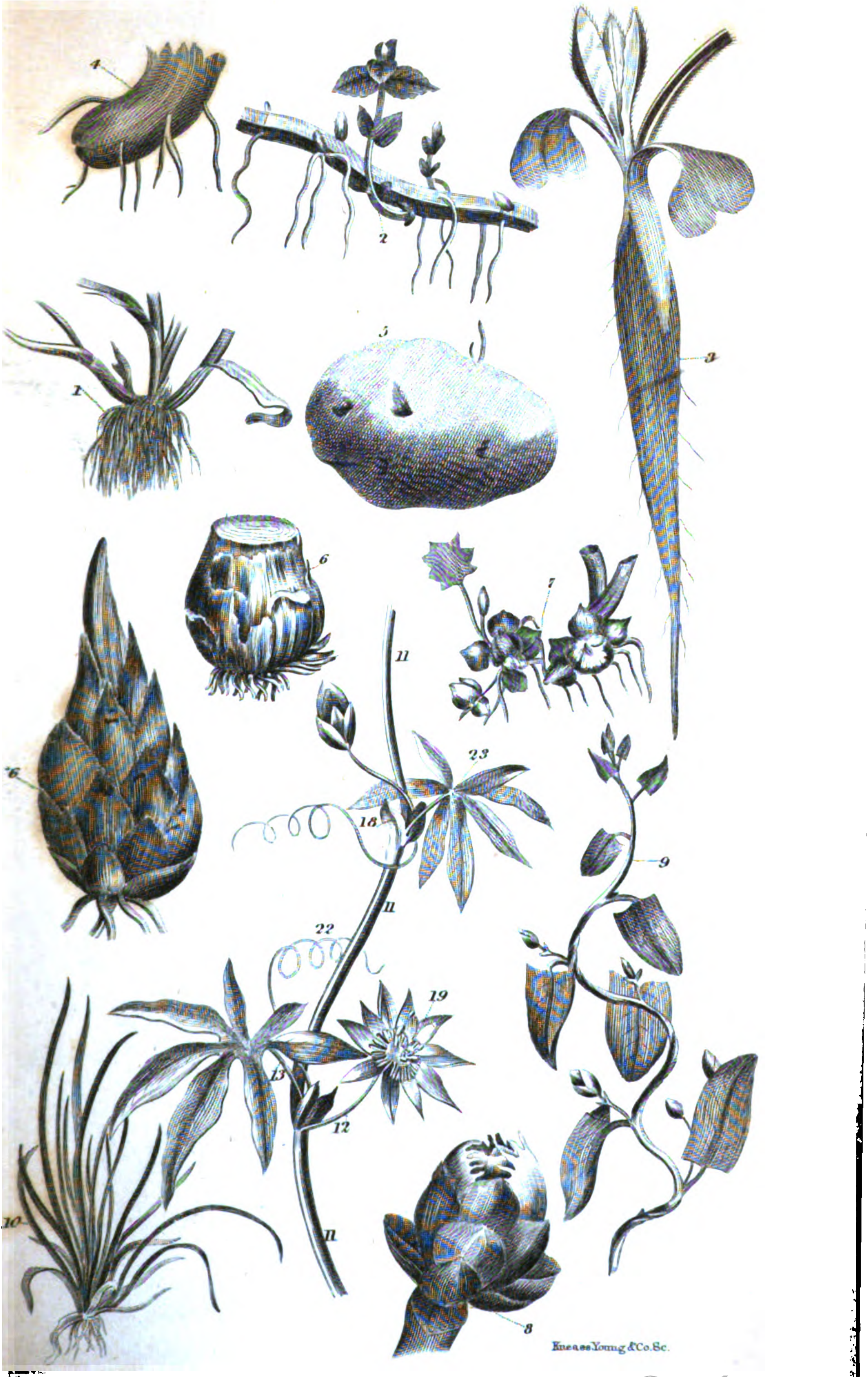


Fig.1.Anas cygnus mansuetus : Mute Swan. Fig.2. A. erythropterus : Bernacle duck. Fig.3.A. mollissima: Eider duck Fig.4.A.marila scaup duck. Fig.5.A.clangula : golden eye : Fig.6. Aptenodytes *patachonica : Patagonian Penguin. Fig.7.* Ardea *stellaris bittern.*

BOTANY.

Plate 1.



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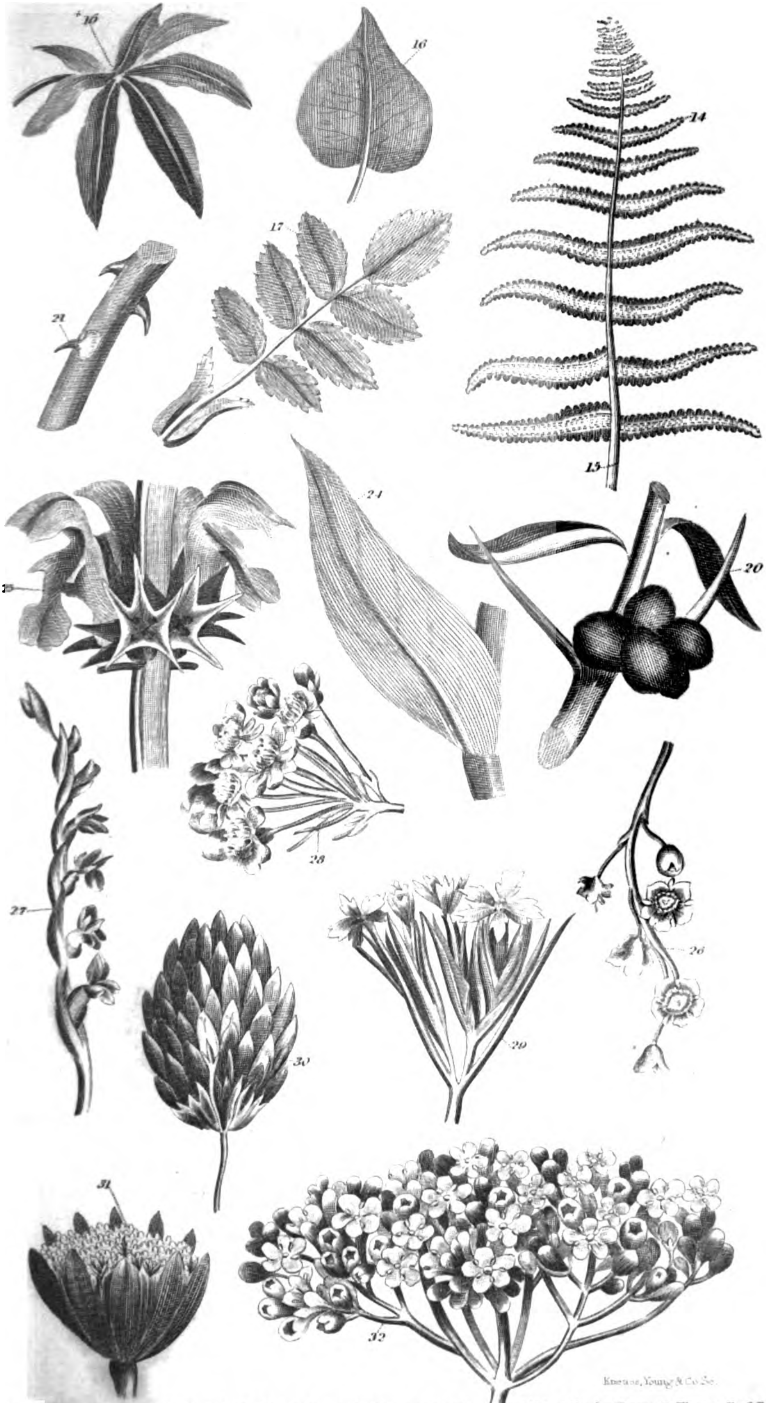
1 Fibrous Root, Grass. 2 Creeping Root, Mint. 3 Spindleshaped Root, Radish. 4 Abrupt Root, Scabiosa Succisa. 5 Tuberous Root, Potatoe.
6 Bulbous Roots, Onion. Lilly. 7 Granulated Root, Saxifraga Granulata. 8 Bud, Horse Chesnut. 9 Stem Bearing leaves & Flowers, Convolvulus.
10 Straw, Grass. 11 Stalk, Passion Flower. 12 Flower Stalk. 13 Foot, Stalk. 18 Stipula. 19 Bractea. 22 Tendril. 23 Gland.



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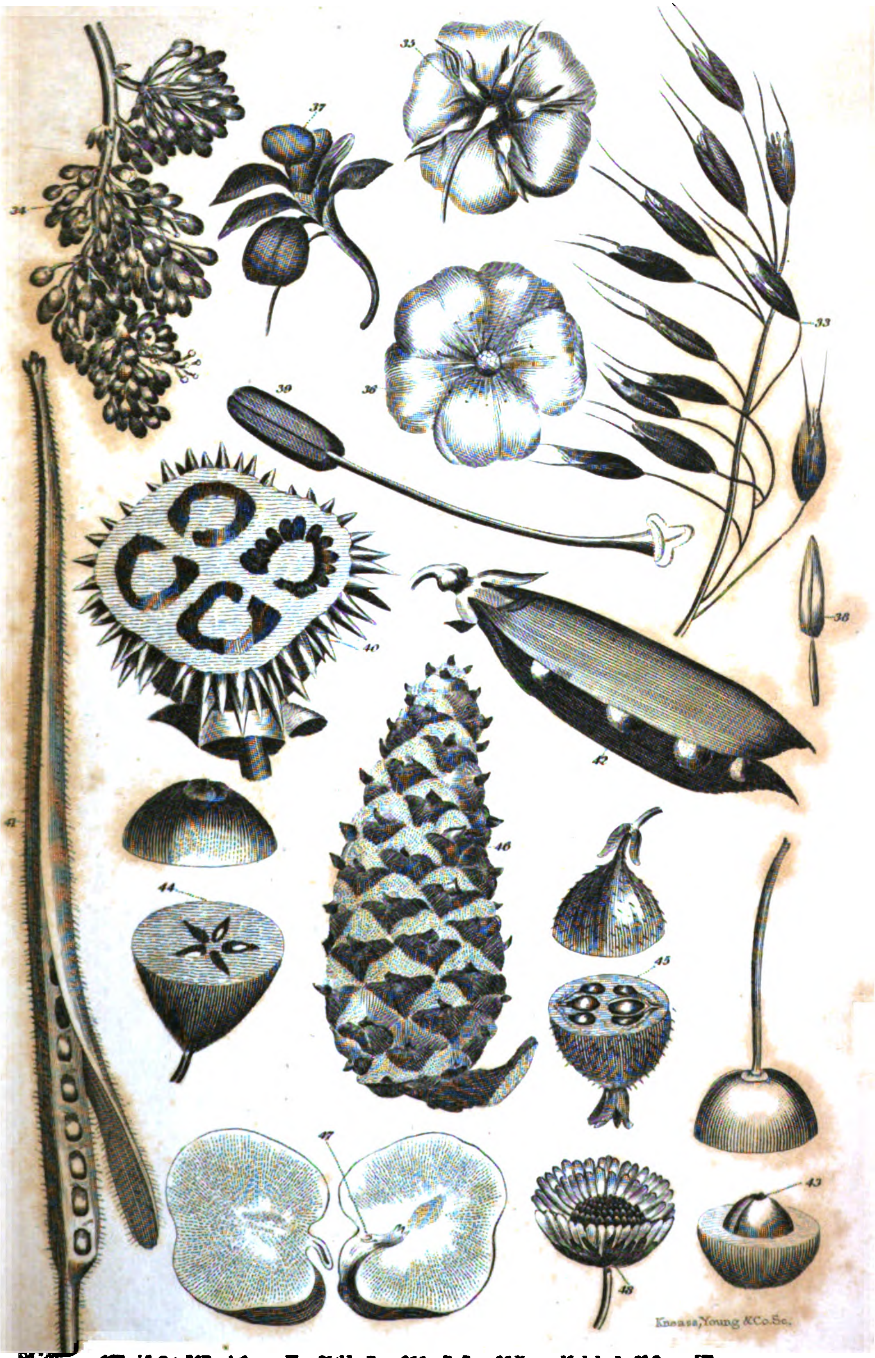
14 Frond, Fern Bearing Seed on the Back. 15 Stipe, Fern _16 Simple leaf, Convolvulus _16 * Lob'd leaf, Passion Flower _17 Pinnate leaf, Rose. 20 Thorns, Hippophae rhamnoides _21 Prickle, Rose _24 Hair, Nettle _25 Whorl, Dead Nettle _26 Cluster, Bunch Currants _27 Spike, Orchis. 28 Corymb, Spiraea Opulifolia _29 Fascicle, Sweet William _30 Head or Tuft, Thrift _31 _ Umbel, Hemlock _32 Cyme, Laurustinus.

BOTANY.

Plate III.



33 Panicle, Oat. _34 Bunch, Common Vine. _35 Calyx, Rose. _36 Corolla, Rose. _37 Nectary, Monkshood. _38 Stamen, Lily.
39 Pistil, Lily. _40 Capsule, Datura. _41 Siliqua, Stock. _42 Legume, Pea. _43 Drupa, Cherry. _44 Pomum, Apple.
45 Bacca, Gooseberry. _46 Strobilus, Fir. _47 Seed, Bean laid open. _48 Receptacle, Daisy.

PISCES.

Plate 1.

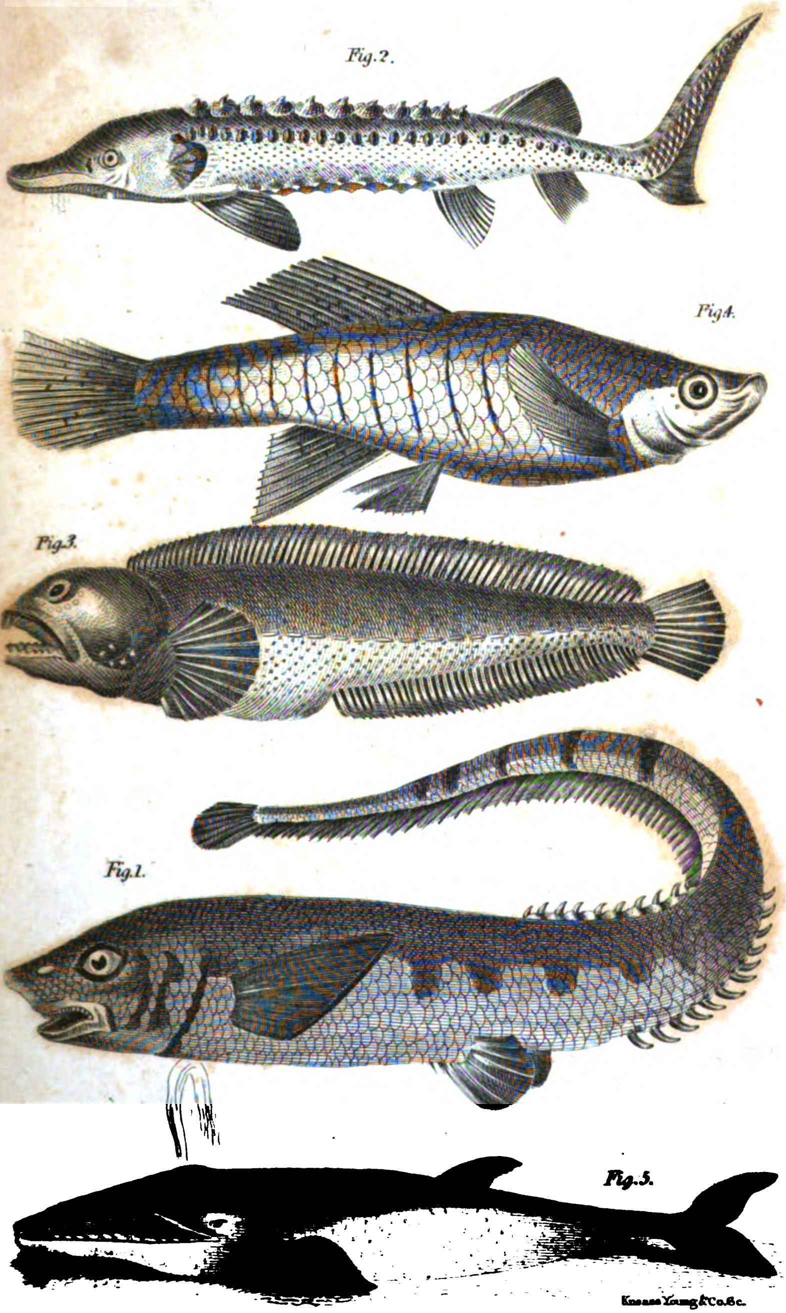


Fig.2.
Fig.4.
Fig.3.
Fig.1.
Fig.5.

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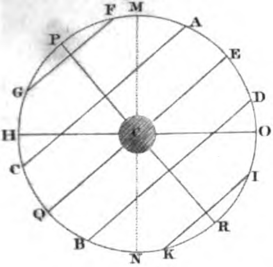
Fig. 1. Acanthonotus nasus: snouted Acanthonotus _ Fig. 2. Acipenser sturio: common sturgeon. Fig. 3. Anarhichas lupus: common wolf-fish _ Fig. 4. Atherina hepsetus: banded atherine _ Fig. 5. Balaena physalus: fin backed mysticete.

Fig. 1.



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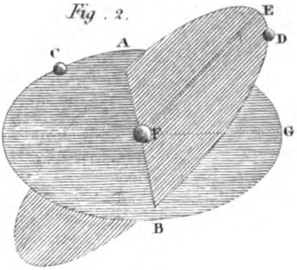

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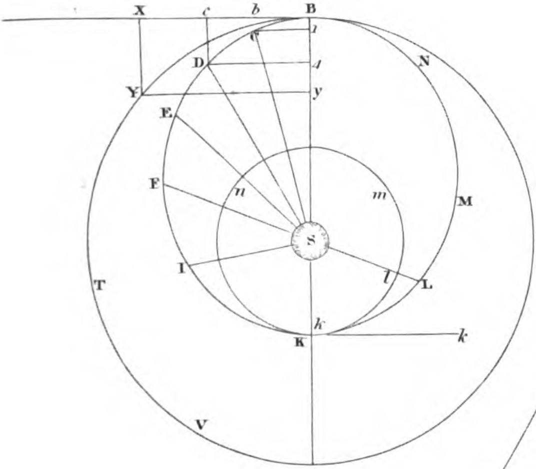

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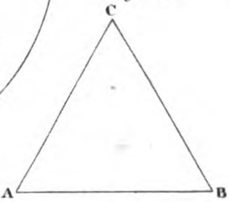

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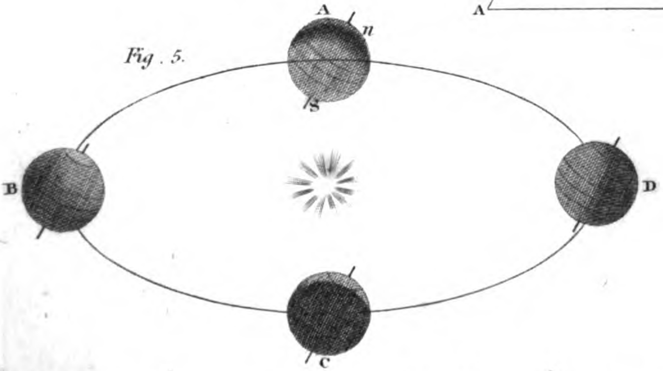

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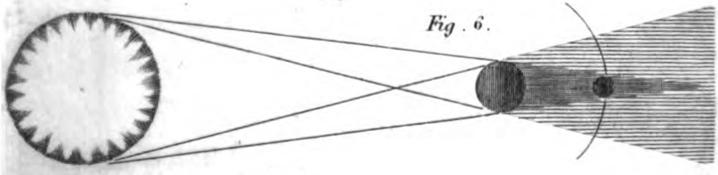

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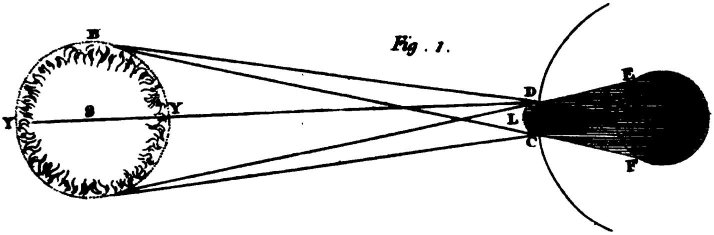

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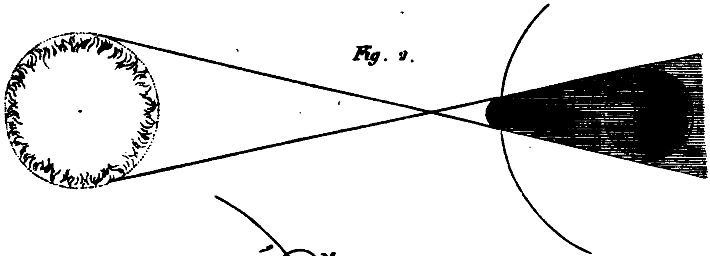

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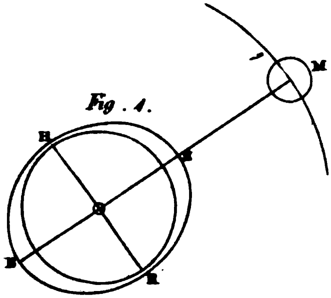

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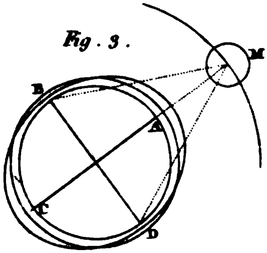

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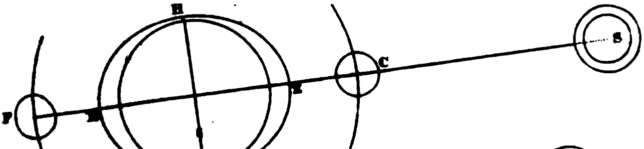

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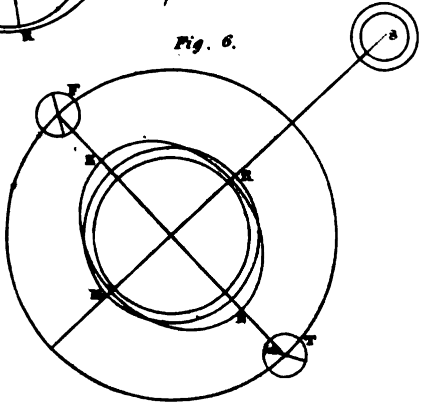

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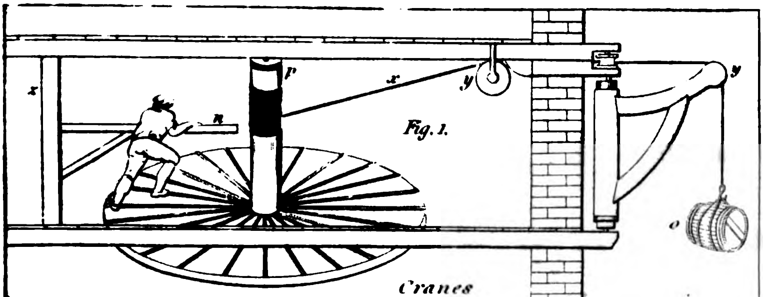

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Cranes

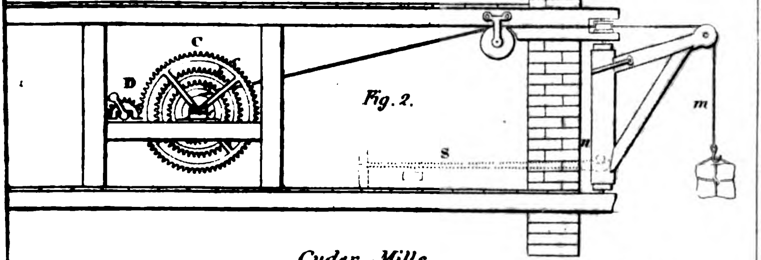
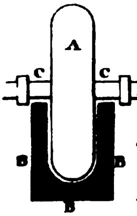


Fig. 2.

Cyder Mills

Fig. 3.



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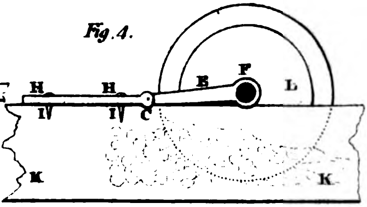

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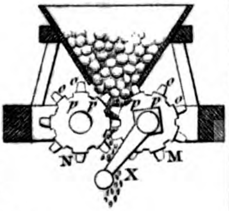

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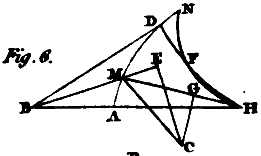

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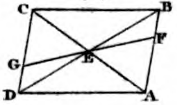

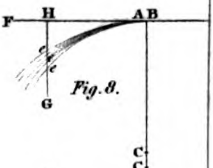

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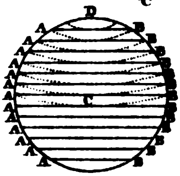

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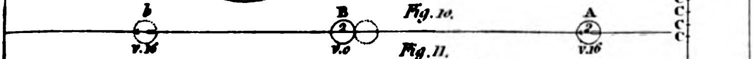

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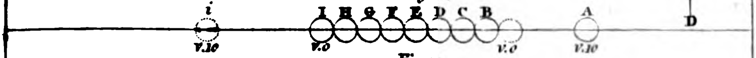

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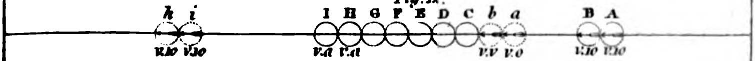

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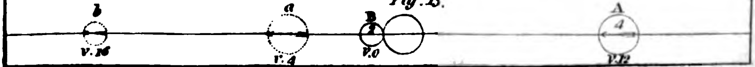

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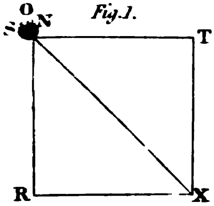
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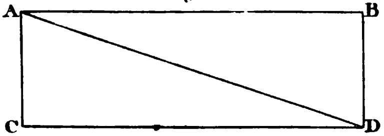
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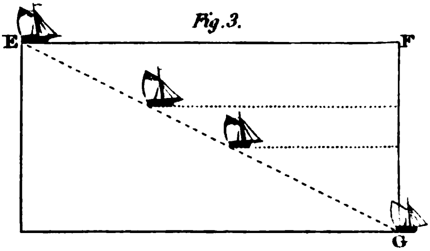
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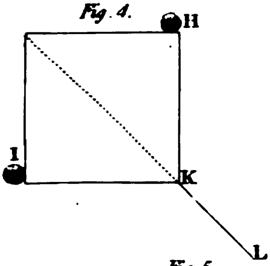
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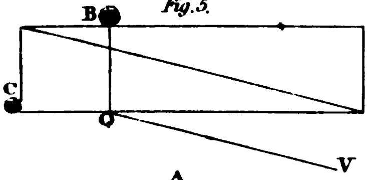
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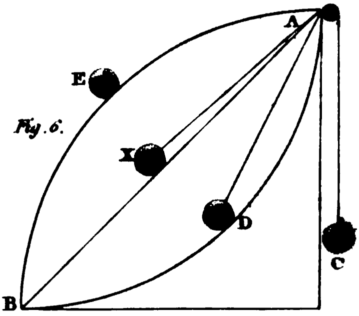
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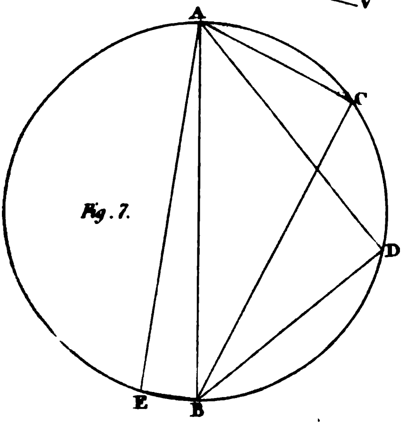
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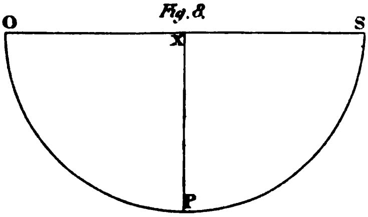
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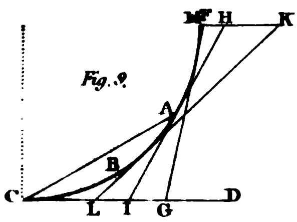
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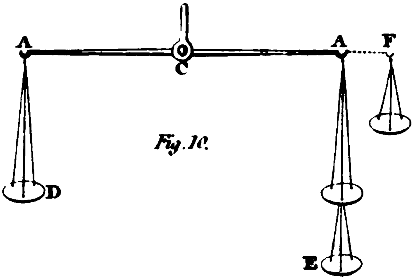
Fig. 10.

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OF THE PRESENT

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BY WILLIAM NICHOLSON,

Author and Proprietor of the Philosophical Journal, and various other Chemical, Philosophical, and Mathematical Works.

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1818.

THE

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AREOPAGUS.

AREOPAGUS, in antiquity, a sovereign tribunal at Athens, famous for the justice and impartiality of its decrees; to which the gods themselves are said to have submitted their quarrels. This tribunal was in great reputation among the Greeks, so that it was denominated "the most sacred and venerable tribunal," and Socrates says that it was deemed so sacred, that if those who had been vicious were elected into it, they immediately gave up their former practices, and conformed to the rules of the senate, because they could not resist the authority of example, but were constrained to appear virtuous. The Romans themselves had so high an opinion of it, that they trusted many of their difficult causes to its decision. Demosthenes says, that in his time neither plaintiff nor defendant had any just reason to be dissatisfied with their proceedings. Innocence, summoned to appear before it, approached without apprehension; and the guilty, convicted and condemned, retired without daring to murmur. Authors are not agreed about the number of the judges who composed this august court. Some reckon thirty-one, others fifty-one, and others five hundred: in reality, their number seems not to have been fixed, but to have been more or less in different years. By an inscription quoted by Volaterranus, it appears they were then three hundred. At first this tribunal only consisted of nine persons, who had all discharged the office of archons, had acquitted themselves with honour in that trust, and had likewise given an account of their administration before the logistæ, and undergone a very rigorous examination. Those who were admitted members of this assembly were strictly watched, and their conduct was scrutinized and judged by the court to which they belonged, without partiality. Trivial faults did not escape censure. A senator, it is said, was punished for having stifled a little bird, which from fear had taken refuge in his bosom; he was thus taught, that he, who has a heart shut against pity, should not be allowed to have the lives of the citizens at his mercy. The members of this august assembly were not allowed to wear crowns, or to obtain any marks of honour conferred by the people, as a recompence for their services; nor were they allowed to solicit any; but they were rewarded by a bounty from the public, and they had also three oboli for every cause in which judgment was given. The areopagites were judges for life. They never sat in judgment but in the open air, and that in the night time; to the intent that their minds might be more present and attentive; and that no object, either of pity or aversion, might make any impression upon them. However, some maintain, that the building in which the areopagites assembled was not wholly uncovered; and they observe, that among the ruins large stones have been found, whose joints are in the same angle with the pediment that must have been used for a covering. Mr. Spon, who examined the antiquities of that illustrious city, found some remains of the areopagus still existing in the middle of the temple of Theseus, which was heretofore in the middle of the city, but is now without the walls. The foundation of the areopagus is a semicircle, with an esplanade of 140 paces round it, which properly made the hall of the areopagus. There is a tribunal cut in the middle of a rock, with seats on each side of it, where the areopagites sat, exposed to the open air. At first they only took cognizance of criminal causes; but in course of time their jurisdiction became of greater extent. This court is recorded as the first that sat upon life and death; and the trial of wilful murder seems to have been the original design of its institution. In later ages, all incendiaries, assassins, conspirators, deserters of their country, treasons, and most capital causes in general, fell under its cognizance. The opinion which the state entertained of the wisdom, gravity, and sanctity of its members, gained for them an unlimited power; insomuch that, according to Solon's regulation of this assembly, the inspection and custody of the laws, the management of the public funds, the guardianship of young men, and the education of youth, according to their rank, were committed to them. Their power extended to persons of all ages and sexes, to punish the idle and profligate, and to reward the sober and virtuous, according to their own pleasure. For this purpose, they were empowered, by entering and examining private houses, to condemn every useless person as dangerous; and every expense not proportioned to the means of the citizen as criminal. Besides, they took cognizance of religious matters, blasphemy, contempt of holy mysteries, the erection and consecration of temples and altars, and the introduction of new ceremonies: nevertheless, they interfered in public affairs only in cases of emergency or danger. As this assembly exhibited the greatest firmness in punishing crimes, and the nicest circumspection in reforming manners; as it never employed chastisement till advice and menaces were slighted; it acquired the esteem and confidence of the people, even whilst it exercised the most absolute power. Its meetings were held three times in every month, *viz.* on the 27th, 28th, and 29th days, but on any urgent business, the senators assembled in the royal portico. The court was divided into several committees, each of which took cognizance of separate causes, if the multiplicity of business would not allow time for them to be brought before the whole senate: and this was done by lots, that the causes might not be prejudged. In crimes that concerned religion or the state, the power of this court was limited to preparing the matter for a trial; and it then made its report to the people, without coming to any conclusion. The accused then had it in his power to offer new pleas in his defence; and the people named orators, to conduct the prosecution before one of the superior courts. Trials in the areopagus were preceded by tremendous ceremonies. The two parties, placed amidst the bleeding members of the victims, took an oath, which they confirmed by dreadful imprecations against themselves and families. They called to witness the Eumenides, who, from a neighbouring temple, dedicated to their worship, seemed to listen to the invocation, and prepared to punish the perjured. They then proceeded to the trial, requiring all pleadings to be conducted in the simplest terms, without exordium, epilogue, or appeal to the passions. After the question had been sufficiently discussed, the judges silently deposited their suffrages in two urns, one of brass, called the urn of death; and the other of wood, called the urn of mercy. This mode of giving votes was afterwards abandoned, and they were delivered in public, by casting their calculi or flints upon two tables, one for those that were acquitted, and the other for those condemned: when the numbers were equal, an inferior officer added, in favour of the accused, the suffrage of Minerva, so called, because, according to an ancient tradition, this goddess, being present in the court of areopagus at the trial of Orestes, gave her casting vote to turn the scale of justice. In some causes the sentence of this court was not final; but an appeal might be made to the courts to which they respectively belonged.

ARETHUSA, in botany, a genus of the Gynandria Decandria class of plants, having no other calyx than a foliacious spatha; the corolla is ringent, and consists of five oblong sub-equal petals; the nectarium consists of a single leaf, divided into two segments; the fruit is an oblong oval capsule, consisting of three valves, and containing one cell, in which are several seeds. There are seven species.

ARETIA, in botany, a genus of the Pentandria Monogynia class of plants, the calyx of which is a perianthium, consisting of a single campanulated, semiquinquefid, and permanent leaf, without any involucrum; the corolla consists of a single petal; the tube is oval, and of the length of the cup; the limb is divided into four segments; and the fruit is a capsule, in which are contained many seeds. There are four species.

ARGEMONE, in botany, a genus of the Polyandria Monogynia class of plants, the calyx of which is a roundish spatha, composed of three hollow, pointed, deciduous leaves; the corolla consists of three roundish, erecto-patent petals, larger than the cup; the fruit is an oval pentangular capsule, containing one cell, and seeming as if formed of five valves; the seeds are numerous and very small; the receptacles are linear, and grow to the angles of the pericarpium: they do not burst. There are three species.

ARGENT, in heraldry, the white colour in the coats of gentlemen, knights, and baronets: the white in the arms of sovereign princes is called luna, and that in the arms of the nobility pearl; this is expressed in engraving by the parts being left plain, without any strokes from the graver.

ARGENTINA, in natural history, a genus of fishes, of the order Abdominales; teeth in the jaws and tongue; gill membrane, with eight rays; vent near the tail; ventral fins many rayed. There are four species. A sphyræna, or European atherine, inhabits the Mediterranean, and sometimes wanders to the British coast, it is from two to four inches long; body round and tapering; back and sides, as far as the lateral line, pale ash mixed with green, below the line and belly fine silvery; the air-bladder is conic on both sides, appearing as if covered with silver leaf, and is used in the manufacture of artificial pearls. A. glossodonta, is a very elegant species, found in the Red Sea: as is also A. machnata; but the other species, A. carolina, which is the size of a small herring, is found in the fresh waters of Carolina.

ARGENTUM *vivum*. See MERCURY.

ARGIL. See ALUMINA.

ARGONAUTA, in natural history, a genus of worms, of the order Testacea. Animal a sepia or clio; shell univalve, spiral, involute membranaceous, one celled. There are five species. A. argo has the keel, or ridge of the shell slightly toothed on each side; it inhabits the Mediterranean and Indian oceans, and is the famous nautilus, supposed, in the early ages of society, to have first taught men the use of sails. When it means to sail it discharges a quantity of water, by which it is made lighter than the sea, and rising to the surface, erects its arms, and throws out a membrane between them, by which means it is driven forwards like a vessel under sail; two of the arms it hangs over the shell, to serve as oars or a rudder. The shell is white or yellowish, with smooth or knotty striæ or ribs, which are sometimes forked; the keel is generally brownish.

ARGOPHYLLUM, in botany, a genus of the Pentandria Monogynia class and order. Calyx five-cleft, superior; corol five-petalled; nectary pyramidal, five-angled, as long as the corol; capsule three-celled, many seeded: found in New Caledonia.

ARGUMENT, in rhetoric and logic, an inference drawn from premises, the truth of which is indisputable, or at least highly probable.

The arguments of orators receive particular denominations, according to the topics from whence they are derived: thus, we meet with arguments from affection, which interest the passions of the person to whom they are addsessed; also with the arguments *a tuto, ad ignaviam, ab invidia*, &c.

In reasoning, Mr. Locke observes, that men ordinarily use four sorts of arguments. The first is, to allege the opinions of men, whose parts and learning, eminency, power, or some other cause, has gained a name, and settled their reputation in the common esteem, with some kind of authority; this may be called *argumentum ad verecundiam*. Secondly, another way is, to require the adversaries to admit what they alledge as a proof, or to assign a better; this he calls *argumentum ad ignorantiam*. A third way is, to press a man with consequences, drawn from his own principles or concessions; this is known by the name of *argumentum ad hominem*. Fourthly, the using proofs drawn from any of the foundations of knowledge or probability; this he calls *argumentum ad judicium*; and observes, that it is the only one of all the four that brings true instruction with it, and advances us in our way to knowledge. For. 1. It argues not another man's opinion to be right, because I, out of respect, or any other consideration, but that of conviction, will not contradict him. 2. It proves not another man to be in the right way, nor that I ought to take the same with him, because I know not a better. 3. Nor does it follow that another man is in the right way, because he has shewn me that I am in the wrong; this may dispose me, perhaps, for the reception of truth, but helps me not to it; that must come from proofs and arguments, and light arising from the nature of things themselves, not from my shamefacedness, ignorance, or error. See the articles REASON and REASONING.

ARGUMENT, in astronomy, denotes a known arch, by means of which we seek another one unknown.

The argument of the moon's latitude is her distance from the node; and the argument of inclination is an arch of a planet's orbit, intercepted between the ascending node and the place of the planet from the sun, numbered according to the succession of the signs.

ARGYTHAMNIA, in botany, a genus of plants of the Monoecia Tetrandria class and order. Essen. char. male calyx four-leaved; petals four: female calyx five-leaved; no corol; three styles, forked; capsule three celled: seeds solitary. There is but a single species, a shrub, found in Jamaica, with a whitish bark; leaves oval; flowers axillary, on very short peduncles.

ARIANS, a denomination of Christians that take their name from Arius, a presbyter of Alexandria, who flourished in the year 315. The propagation of this doctrine was the occasion of the celebrated council of Nice by Constantine, in the year 325. Arius acknowledged Christ to be God, in a subordinate sense, and considered his death to be a propitiation for sin. The Arians acknowledge, that the Son was the word, though they deny its being eternal, contending only that it had been created prior to all other beings. They maintain that Christ is not the eternal God; but, in opposition to the Unitarians, they contend for his pre-existence, a doctrine which they found on various passages of scriptue, particularly these two, "before Abraham was, I am;" and "glorify me with the glory which I had with thee before the world was." Arians differ among themselves as to the extent of the doctrine. Some of them believe Christ to have been the Creator of the world, and on that account has a claim to religious worship; others admit of his pre-existence simply. Hence the appellations high and low Arians. Dr. Clarke, Rector of St. James, in his "Scripture Doctrine of the Trinity;" Mr. Henry Taylor, Vicar of Portsmouth, in a work entitled "Ben Mordicai's Apology;" Mr. Tomkins, in his "Mediator;" and Mr. Hopkins, in his "Appeal to the Common Sense of all Christian People;" have been deemed among the most able advocates of Arianism. Dr. Price has been one of the last writers in behalf of this doctrine: in his sermons "On the Christian Doctrine" will be found an able defence of low Arianism. See also a tract published in 1805, by Basanistes.

ARIES, in astronomy, a constellation of fixed stars, drawn on the globe in the figure of a ram. It is the first of the twelve signs of the zodiac, from which a twelfth part of the ecliptic takes its denomination. It is marked thus ♈, and consists of sixty-six stars.

ARISH, a long measure used in Persia, containing 3197 English feet.

ARISTA, among botanists, a long needle-like beard, which stands out from the husk of a grain of corn, grass, &c.

ARISTARCHUS, in biography, a celebrated Greek philosopher and astronomer, and a native of the city of Samos; but at what period he flourished is not certain. It must have been before the time of Archimedes, as some parts of his writings and opinions are cited by that author. He held the doctrine of Pythagoras as to the system of the world, but whether he lived before or after him is not known. He maintained that the sun and stars were fixed in the heavens, and that the earth moved in a circle about the sun, at the same time that it revolved about its own axis. He determined, that the annual orbit of the earth, compared with the distance of the fixed stars, is but as a point. For these his opinions, which time has proved to be undeniably true, he was censured by his contemporaries, some of whom went about to prove that Greece ought to have punished Aristarchus for his heresy. This philosopher invented a peculiar kind of sun-dial, mentioned by Vitruvius. There is now extant only a treatise upon the magnitude and distance of the sun and moon, which was translated into the Latin, and commented upon by Commandine, who published it, with Pappus's explanations, in 1572.

ARISTEA, in botany, a genus of plants of the Triandria Monogynia class and order. Petals six; style declined: stigma funnel-form, gaping; capsule inferior, many-seeded. There is but one species: a Cape plant; low; leaves veined and narrow; flowers in downy heads.

ARISTIDA, in botany, a genus of the Triandria Digynia class of plants, the calyx of which is a bivalve tubulated glume, of the length of the corolla; the corolla is a glume of one valve, opening longitudinally, hairy at the base, and terminated by three sub-equal patulous aristæ; the fruit is a connivent glume, containing a naked filiform single seed, of the length of the corolla. There are ten species.

ARISTOCRACY, a form of government, where the supreme power is vested in the principal persons of the state, either on account of their nobility, or their capacity and probity.

Aristocracies, says Archdeacon Paley, are of two kinds; first, where the power of the nobility belongs to them in their collective capacity alone; that is, where, although the government reside in an assembly of the order, yet the members of the assembly, separately and individually, possess no authority or privilege beyond the rest of the community: such is the case in the constitution of Venice. Secondly, where the nobles are severally invested with great personal power and immunities, and where the power of the senate is little more than the aggregate power of the individuals who compose it: such was the case in the constitution of Poland. Of these two forms of government, the first is more tolerable than the last; for although many, or even all, the members of a senate should be so profligate, as to abuse the authority of their stations in the prosecution of private designs, yet, whilst all were not under a temptation to the same injustice, and having the same end to gain, it would still be difficult to obtain the consent of a majority to any specific act of oppression, which the iniquity of an individual might prompt him to propose: or, if the will were the same, the power is more confined; one tyrant, whether the tyranny reside in a single person, or a senate, cannot exercise oppression in so many places at the same time, as may be carried on by the dominion of a numerous nobility over their respective vassals and dependents. Of all species of domination, this is the most odious; the freedom and satisfaction of private life are more restrained and harassed by it, than by the most vexatious laws, or even by the lawless will of an arbitrary monarch, from whose knowledge, and from whose injustice, the greatest part of his subjects are removed by their distance, or concealed by their obscurity. An aristocracy of this kind has been productive, in several instances, of disastrous revolutions, and the people have concurred with the reigning prince, in exchanging their condition for the miseries of despotism. This was the case in Denmark about the middle of the seventeenth century, and more lately in Sweden. In England, also, the people beheld the depression of the barons, under the house of Tudor, with satisfaction, although they saw the crown acquiring thereby a power, which no limitations, provided at that time by the constitution, were likely to confine.

From such events this lesson may be drawn: "That a mixed government, which admits a patrician order into the constitution, ought to circumscribe the personal privileges of the nobility, especially claims of hereditary jurisdiction and local authority, with a jealousy equal to the solicitude with which it provides for its own preservation." Paley's Princ. of Philos.

ARISTOLOCHIA, in botany, *birth-wort*, a genus of plants of the Gynandria Hexandria class and order. Stigmata six; no calyx; corol one-petalled, tubular, tongue-shaped; capsule inferior, six-celled. There are 27 species, most foreign.

ARISTOTELIA, a genus of the Dodecandria Monogynia class and order: calyx five-leaved; petals five; style three-cleft; berry three-celled, with two seeds in each. One species, found in Chili, a shrub, leaves ever-green; flowers white in axillary racemes.

ARISTOTELIAN, something relating to Aristotle: thus we read of the Aristotelian philosophy, school, &c. See PERIPATETICS.

ARITHMETIC, the art of numbering; or, that part of mathematics, which considers the powers and properties of numbers, and teaches how to compute or calculate truly, and with expedition and ease. By some authors it is also defined the science of discreet quantity. It consists chiefly in the four great rules or operations of Addition, Subtraction, Multiplication, and Division. Concerning the origin and invention of arithmetic we have very little information: history fixes neither the author nor the time. Some knowledge, however, of numbers must have existed in the earliest ages of mankind. This knowledge would be suggested to them, whenever they opened their eyes, by their own fingers, and by their flocks and herds, and by the variety of objects that surrounded them. At first, indeed, their powers of numeration would be of very limited extent; and before the art of writing was invented, it must have depended on memory, or on such artificial helps as might most easily be obtained. To their ten fingers they would, without doubt, have recourse in the first instance; and hence they would be naturally led to distribute numbers into periods, each of which consisted of ten units. This practice was common among all nations, the ancient Chinese, and an obscure people mentioned by Aristotle, excepted. But though some kind of computation must have commenced at a very early period, the introduction of arithmetic as a science, and the improvements it underwent, must, in a great degree, depend upon the introduction and establishment of commerce; and as commerce was gradually extended and improved, and other sciences were discovered and cultivated, arithmetic would be improved likewise. It is therefore probable, that if it was not of Tyrian invention, it must have been much indebted to the Phœnicians or Tyrians. Proclus, indeed, in his commentary on the first book of Euclid, says, that the Phœnicians, by reason of their traffic and commerce, were the first inventors of arithmetic; and Strabo also informs us, that in his time it was attributed to the Phœnicians. Others have traced the origin of this art to Egypt; and it has been a general opinion, sanctioned by the authorities of Socrates and Plato, that Theut or Thot was the inventor of numbers; that from hence the Greeks adopted the idea of ascribing to their Mercury, corresponding to the Egyptian Theut or Hermes, the superintendance of commerce and arithmetic. With the Egyptians we ought also to associate the Chaldeans, whose astronomical disquisitions and discoveries, in which they took the lead, required a considerable acquaintance with arithmetic. From Asia it passed into Egypt, as Josephus says, by means of Abraham. Here it was greatly cultivated and improved; insomuch, that a large part of the Egyptian philosophy and theology seems to have turned altogether upon numbers. Kircher shews, that the Egyptians explained every thing by numbers; Pythagoras himself affirming, that the nature of numbers pervades the whole universe, and that the knowledge of numbers is the knowledge of the Deity. From Egypt, arithmetic was transmitted to the Greeks by Pythagoras and his followers; and among them it was the subject of particular attention, as we perceive in the writings of Euclid, Archimedes, and others; with the improvements derived from them, it passed to the Romans, and from them it came to us. The ancient arithmetic was very different from that of the moderns in various respects, and particularly in the method of notation. The Indians are at this time very expert in computing, by means of their fingers, without the use of pen and ink; and the natives of Peru, by the different arrangements of their grains of maize, surpass the European, aided by all his rules, with regard both to accuracy and dispatch. The Hebrews and Greeks, however, at a very early period, and after them also the Romans, had recourse to the letters of their alphabet for the representation of numbers. The Greeks, in particular, had two different methods: the first resembled that of the Romans, which is sufficiently known, as it is still used for distinguishing the chapters and sections of books, dates, &c. They afterwards had a better method, in which the first nine letters of the alphabet represented the first numbers from 1 to 9, and the next nine letters represented any number of tens, from 1 to 9, that is, 10, 20, &c. to 90. Any number of hundreds they expressed by other letters, supplying what they wanted by some other marks, or characters: and in this order they proceeded, using the same letters again, with different marks to express thousands, tens of thousands, hundreds of thousands, &c.; thus approaching very near to the more perfect decuple scale of progression used by the Arabians, who acknowledge, as some have said, that they received it from the Indians. Archimedes, also, in his "Arenarius," used a particular scale and notation of his own. In the second century of the christian era, Ptolemy is supposed to have invented the sexagesimal numeration and notation, and this method is still used by astronomers and others, for the subdivision of the degrees of circles. These several modes of notation, above recited, were so operose and inconvenient, that they limited the extent, and restrained the progress of arithmetic, so that it was applicable, with great difficulty and embarrassment, to the other sciences, which required its assistance. The Greeks, if we except Euclid, who in his elements furnished many plain and useful properties of numbers, and Archimedes in his Arenarius, contributed little to the advancement of this science towards perfection. From Boethius we learn, that some Pythagoreans had invented and employed, in their calculations, nine particular characters, whilst others used the ordinary signs, namely, the letters of the alphabet. These characters he calls apices; and they are said greatly to resemble the ancient Arabic characters, which circumstance suggests a suspicion of their authenticity. Indeed, the MSS. of Boethius, in which these characters, resembling those of the Arabian arithmetic, are found, not being more ancient than three or four centuries, confirm the opinion that they are the works of a copyist. Upon the whole, this treatise of Boethius does not warrant our rejecting the commonly received system with regard to the origin of our arithmetic; but if we suppose that the Arabians derived their knowledge of it from the Indians, it is more probable that it was one of the inventions which Pythagoras spread among the Indians, than that those persons should have obtained it from the Greeks.

The introduction of the Arabian or Indian notation into Europe, about the tenth century, made a material alteration in the state of arithmetic; and this, indeed, was one of the greatest improvements which this science had received since the first discovery of it. This method of notation, now universally used, was probably derived originally from the Indians by the Arabians, and not, as some have supposed, from the Greeks; and it was brought from the Arabians into Spain by the Moors or Saracens, in the tenth century. Gerbert, who was afterwards Pope, under the name of Silvester II. and who died in the year 1003, brought this notation from the Moors of Spain into France, long before the time of his death, or, as some think, about the year 960; and it was known among us in Britain, as Dr. Wallis has shewn, in the beginning of the eleventh century, if not somewhat sooner. As literature and science advanced in Europe, the knowledge of numbers was also extended, and the writers in this art were very much multiplied. The next considerable improvement in this branch of science, after the introduction of the numeral figures of the Arabians or Indians, was that of decimal parts, for which we are indebted to Regiomontanus; who, about the year 1464, in his book of "Triangular Canons," set aside the sexagesimal subdivisions, and divided the radius into 60,000,000 parts; but afterwards he altogether waved the ancient division into 60, and divided the radius into 10,000,000 parts; so that if the radius be denoted by 1, the sines will be expressed by so many places of decimal fractions as the cyphers following 1. This seems to have been the first introduction of decimal parts. To Dr. Wallis we are principally indebted for our knowledge of circulating decimals, and also for the arithmetic of infinites. The last, and perhaps, with regard to its extensive application and use, the greatest improvement which the art of computation ever received, was that of logarithms, which we owe to Baron Neper or Napier, and Mr. Henry Briggs. See LOGARITHMS.

ARITHMETIC, *theoretical*, is the science of the properties, relations, &c. of numbers, considered abstractedly, with the reasons and demonstrations of the several rules. Euclid furnishes a theoretical arithmetic, in the seventh, eighth, and ninth books of his elements.

ARITHMETIC, *practical*, is the art of numbering or computing; that is, from certain numbers given, of finding certain others whose relation to the former is known. As, if two numbers, 10 and 5, are given, and we are to find their sum, which is 15, their difference 5, their product 50, their quotient 2.

The method of performing these operations generally we shall now proceed to shew, reserving for the alphabetical arrangement those articles, which, though dependent on the first four rules, do not necessarily make a fundamental part of arithmetic.

ADDITION.

Addition is that operation by which we find the amount of two or more numbers. The method of doing this in simple cases is obvious, as soon as the meaning of number is known, and admits of no illustration. A young learner will begin at one of the numbers, and reckon up as many units separately as there are in the other, and practice will enable him to do it at once. It is impossible, strictly speaking, to add more than two numbers at a time. We must first find the sum of the first and second, then we add the third to that number, and so on. However, as the several sums obtained are easily retained in the memory, it is neither necessary nor usual to mark them down. When the numbers consist of more figures than one, we add the units together, the tens together, and so on. But if the sum of the units exceed ten, or contain ten several times, we add the number of tens it contains to the next column, and only set down the number of units that are over. In like manner we carry the tens of every column to the next higher. And the reason of this is obvious from the value of the places; since an unit in any higher places signifies the same thing as ten in the place immediately lower.

Rule. Write the numbers distinctly, units under units, tens under tens, and so on. Then reckon the amount of the right-hand column; if it be under ten, mark it down; if it exceed ten, mark the units only, and carry the tens to the next place. In like manner carry the tens of each column to the next, and mark down the full sum of the left-hand column.

Ex. 1.	*Ex.* 2.	*Ex.* 3.
432	10467530	457974683217
215	37604	2919792935
394	63254942	47374859621
260	43219	24354642
409	856757	925572199991
245	2941275	473214
132	459	499299447325
694	41210864	10049431
317	52321975	41
492	4686	5498936009
243	43264353	943948999274
Ans. 3833		

ARITHMETIC.

As it is of great consequence in business to perform addition readily and exactly, the learner ought to practise it till it become quite familiar. If the learner can readily add any two digits, he will soon add a digit to a higher number with equal ease. It is only to add the unit place of that number to the digit, and if it exceed ten, it raises the amount accordingly. Thus, because 8 and 6 are 14, 48 and 6 are 54. It will be proper to mark down under the sums of each column, in a small hand, the figure that is carried to the next column. This prevents the trouble of going over the whole operation again, in case of interruption or mistake. If you want to keep the account clean, mark down the sum and figure you carry on a separate paper, and after revising them, transcribe the sum only. After some practice, we ought to acquire the habit of adding two or more figures at one glance. This is particularly useful when two figures which amount to 10, as 6 and 4, or 7 and 3, stand together in the column. Every operation in arithmetic ought to be revised to prevent mistakes; and as one is apt to fall into the same mistake if he revise it in the same manner he performed it, it is proper either to alter the order; or else to trace back the steps by which the operation advanced, which will lead us at last to the number we began with. When the given number consists of articles of different value, as pounds, shillings, and pence, or the like, which are called different denominations, the operations in arithmetic must be regulated by the value of the articles. We shall give here a few of the most useful tables for the learner's information, referring for other information to the articles, MEASURES, WEIGHTS, &c.

I. STERLING MONEY.

4 Farthings = 1 penny, marked *d.*
12 Pence = 1 shilling, *s.*
20 Shillings = 1 pound, *L.*

II. TROY WEIGHT.

24 Grains = 1 pennyweight, *dwt.*
20 Pennyweights = 1 ounce, *oz.*
12 Ounces = 1 pound, *lb.*

III. AVOIRDUPOIS WEIGHT.

16 Drams = 1 ounce, *oz.*
16 Ounces = 1 pound, *lb.*
28 Pounds = 1 quarter, *qr.*
4 Quarters = 1 hundred weight, *C.*
20 Hundred weight = 1 ton. *T.*

IV. ENGLISH DRY MEASURE.

2 Pints = 1 quart.
4 Quarts = 1 gallon.
2 Gallons = 1 peck.
4 Pecks = 1 bushel.
8 Bushels = 1 quarter.

V. LONG MEASURE.

12 Inches = 1 foot.
3 Feet = 1 yard.
5½ Yards = 1 pole.
40 Poles = 1 furlong.
8 Furlongs = 1 mile.
3 Miles = 1 league.

VI. ENGLISH LAND MEASURE.

30¼ Square yards = 1 pole or perch.
40 Poles = 1 rood.
4 Roods = 1 acre.

VII. CLOTH MEASURE.

2¼ Inches = 1 nail.
4 Nails = 1 quarter.
4 Quarters = 1 yard.
5 Quarters = 1 English ell.

Rule for Compound Addition. Arrange like quantities under like, and carry according to the value of the higher place. When you add a denomination which contains more columns than one, and from which you carry to the higher by 20, 30, or any even number of tens, first add the units of that column and mark down their sum, carrying the tens to the next column; then add the tens, and carry to the higher denomination, by the number of tens that it contains of the lower. For example, in adding shillings, carry by 10 from the units to the tens, and by 2 from the tens to the pounds. If you do not carry by an even number of tens, first find the complete sum of the lower denomination, then inquire how many of the higher that sum contains, and carry accordingly, and mark the remainder, if any, under the column. For example, if the sum of column of pence be 43, which is three shillings and seven pence, mark 7 under the pence column, and carry 3 to that of the shillings.

Examples in sterling Money.

L.	*s.*	*d.*
215 ..	3 ..	9
172 ..	18 ..	4
645 ..	7 ..	7
737 ..	2 ..	3
35 ..	3 ..	9
9 ..	0 ..	7
1814 ..	16 ..	3

L.	*s.*	*d.*
169 ..	16 ..	10
36 ..	12 ..	9¾
54 ..	7 ..	6
30 ..	0 ..	1¼
7 ..	19 ..	6
707 ..	19 ..	11
1006 ..	16 ..	8

ARITHMETIC.

T.	C.	qr.	lb.
–	14	1	16
2	18	1	16
–	1	2	27
3	1	–	10
–	17	2	24
–	15	3	18
4	6	–	5
12	15	1	4

T.	C.	qr.	lb.
6	3	–	19
5	7	3	26
3	2	2	—
4	3	1	10
–	18	1	12
1	1	1	1
5	3	–	7
25	19	2	19

Examples for Practice.

MONEY.

L.	s.	d.
257	1	5½
734	3	7¾
595	5	3
152	14	7½
207	5	4
798	16	7¾

L.	s.	d.
525	2	4½
179	3	5
250	4	7¼
975	3	5¼
254	5	7
379	4	5¾

L.	s.	d.
21	14	7¼
75	16	0
79	2	4¼
57	16	5½
26	13	8¾
54	2	7

L.	s.	d.
127	4	7½
525	3	5
271	0	5
542	9	1
379	4	3½
215	5	8¼

L.	s.	d.
261	17	1¼
379	13	5
257	16	7¾
184	13	5
725	2	3¼
359	6	3

L.	s.	d.
31	1	1½
75	13	1
39	19	6¼
97	17	3¼
36	13	5
24	16	3¼

TROY WEIGHT.

lb.	oz.	dwt.
7	1	2
3	2	17
5	1	15
7	10	11
2	7	13
3	11	16

lb.	oz.	dwt.	gr.
5	2	15	22
3	11	17	14
3	7	15	19
9	1	13	21
3	9	7	23
5	2	15	17

AVOIRDUPOIS WEIGHT.

lb.	oz.	dr.
152	13	15
272	14	10
303	15	11
255	10	4
173	6	2
625	13	13

t.	cwt.	qr.	lb.
7	17	2	12
5	5	3	14
2	4	1	17
3	18	2	19
7	9	3	20
8	5	1	24

APOTHECARIES WEIGHT.

℔	℥	ʒ	℈
17	10	7	1
9	5	2	2
27	11	1	2
9	5	6	1
37	10	5	2
49	—	7	0

℔	℥	ʒ	℈	gr.
7	2	1	0	12
3	1	7	1	17
9	10	2	0	14
7	5	7	1	15
3	9	5	2	13
7	1	4	4	18

CLOTH MEASURE.

yd.	qr.	n.
135	3	3
70	2	2
95	3	0
179	1	3
26	0	1
279	2	1

EE.	qr.	n.
272	2	1
152	1	2
79	0	1
156	2	0
79	3	1
154	2	1

LONG MEASURE.

yd.	feet.	in.	bar.
225	1	9	1
171	0	3	2
52	2	3	2
397	0	10	1
154	2	7	2
137	1	4	1

lea.	m.	fur.	p.
72	2	1	19
27	1	7	22
35	2	5	31
79	0	6	12
51	1	6	17
72	0	5	21

LAND MEASURE.

a.	r,	p.
726	1	31
219	2	17
1455	3	14
879	1	21
1195	2	14

a.	r.	p.
1232	1	14
327	0	19
131	2	15
1219	1	18
459	2	17

WINE MEASURE.

hhds.	gal.	qts.
31	57	1
97	18	2
76	13	1
55	46	2
87	38	3
55	17	1

T.	hhds.	gal.	qts.
14	3	27	2
19	2	56	3
17	0	39	2
75	2	16	1
54	1	19	2
97	3	54	3

ALE AND BEER MEASURE.

A.B.	fir.	gal.
25	2	7
17	3	5
96	2	6
75	1	4
96	3	7
75	0	5

hhds.	gal.	qr.
76	51	2
57	3	3
97	27	3
22	17	2
32	19	3
55	38	3

DRY MEASURE.

ch.	bu.	pks.
75	2	1
41	24	1
92	16	1
70	13	2
54	17	3
79	25	1

lasts.	weys.	qts.	bu.	pks.
38	1	4	5	3
47	1	3	6	2
62	0	2	4	3
45	1	4	3	3
78	1	1	2	2
29	1	3	6	2

TIME.

w.	d.	h.
71	3	11
51	2	9
76	0	21
95	3	21
79	1	15

w.	d.	h.	m.	sec.
57	2	15	42	41
95	3	21	27	51
76	0	15	37	28
53	2	21	42	27
98	2	18	47	38

When one page will not contain the whole account, we add the articles it contains, and write against their sum *carried forward*, and we begin the next page with the sum of the foregoing, writing against it *brought forward*. When the articles fill several pages, and their whole sum is known, which is the case in transcribing accounts, it is best to proceed in the following manner: add the pages, placing the sums in a separate paper; then add the sums, and if the amount of the whole be right, it only remains to find what number should be placed at the foot and top of the pages. For this purpose, repeat the sum of the first page on the same line; add the sums of the first and second, placing the amount in a line with the second; to this add the sum of the third, placing the amount in a line with the third. Proceed in the like manner with the others; and if the last sum corresponds with the amount of the page, it is right. These sums are transcribed at the foot of the respective pages, and tops of the following ones.

SUBTRACTION.

Subtraction is the operation by which we take a lesser number from a greater, and find their difference. It is exactly opposite to addition, and is performed by learners in a like manner, beginning at the greater, and reckoning downwards the units of the lesser. The greater is called the minuend, and the lesser the subtrahend. If any figure of the subtrahend be greater than the corresponding figure of the minuend, we add ten to that of the minuend, and, having found and marked the difference, we add one to the next place of the subtrahend. This is called borrowing ten. The reason will appear, if we consider that, when two numbers are equally increased by adding the same to both, their difference will not be altered. When we proceed as directed above, we add ten to the minuend, and we likewise add one to the higher place of the subtrahend, which is equal to ten of the lower place.

Rule.—Subtract units from units, tens from tens, and so on. If any figure of the subtrahend be greater than the corresponding one of the minuend, borrow ten.

Examples.

Minuend	173694	738641
Subtrahend	21453	379235
Remainder	152241	359406

To prove subtraction, add the subtrahend and remainder together; if their sum be equal to the minuend, the account is right. Or subtract the remainder from the minuend. If the difference be equal to the subtrahend, the account is right.

Rule for Compound Subtraction. Place like denominations under like, and borrow, when necessary, according to the value of the higher place.

Examples.

L.	s.	d.
146	3	3
58	7	6
87	15	9

cwt.	qr.	lb.
12	3	19
4	3	24
7	3	23

Examples for Practice.

TROY WEIGHT.

	lb.	oz.	dt.	gr.	lb.	oz.	dt.	gr.
Bought	52	1	7	2	7	2	2	7
Sold	39	0	15	7	5	7	1	5
Unsold								

ARITHMETIC.

AVOIRDUPOIS WEIGHT.

lb. *oz.* *dr.* *cwt.* *qrs.* *lb.* *T.* *cwt.* *qrs.* *lb.*
35 .. 10 .. 5 35 .. 1 .. 21 21 .. 1 .. 2 .. 7
29 .. 12 .. 7 25 .. 1 .. 10 9 .. 1 .. 3 .. 5

APOTHECARIES WEIGHT.

℔ ℥ ʒ ℈ ℔ ℥ ʒ ℈ *gr.*
5 .. 2 .. 1 .. 0 9 .. 7 .. 2 .. 1 .. 13
2 .. 5 .. 2 .. 1 5 .. 7 .. 3 .. 1 .. 18

CLOTH MEASURE.

FE. *qrs.* *n.* *yds.* *qrs.* *n.* *EE.* *qrs.* *n.*
35 .. 2 .. 2 71 .. 1 .. 2 35 .. 2 .. 1
17 .. 2 .. 1 3 .. 2 .. 1 14 .. 3 .. 2

LONG MEASURE.

yds. *ft.* *in.* *bar.* *leag.* *mi.* *fur.* *po.*
107 .. 2 .. 10 .. 1 147 .. 2 .. 6 .. 29
78 .. 2 .. 11 .. 2 58 .. 2 .. 7 .. 33

LAND MEASURE.

a. *r.* *p.* *a.* *r.* *p.*
175 .. 1 .. 27 325 .. 2 .. 1
59 .. 0 .. 27 279 .. 3 .. 5

WINE MEASURE.

hhd. *gal.* *qts.* *pt.* *tun.* *hhd.* *gal.* *qts.*
47 .. 47 .. 2 .. 1 42 .. 2 .. 37 .. 2
28 .. 59 .. 3 .. 0 17 .. 3 .. 49 .. 3

ALE AND BEER MEASURE.

AB. *fir.* *gal.* *BB.* *fir.* *gal.* *hhd.* *gal.* *qts.*
25 .. 1 .. 2 37 .. 2 .. 1 27 .. 27 .. 1
21 .. 1 .. 5 25 .. 1 .. 7 12 .. 50 .. 2

DRY MEASURE.

qu. *bu.* *p.* *qu.* *bu.* *p.* *ch.* *bu.* *p.*
72 .. 1 .. 2 65 .. 2 .. 1 79 .. 3 .. 0
35 .. 2 .. 3 57 .. 2 .. 3 54 .. 7 .. 1

TIME.

yrs. *mo.* *we.* *da.* *ho.* *min.* *sec.*
79 .. 8 .. 2 .. 4 34 .. 42 .. 45
23 .. 9 .. 3 .. 5 19 .. 53 .. 47

The reason for borrowing is the same as in simple subtraction. Thus, in subtracting pence, we add 12 pence when necessary to the minuend, and at the next step we add one shilling to the subtrahend. When there are two places in the same denomination, if the next higher contain exactly so many tens, it is best to subtract the units first, borrowing ten when necessary; and then subtract the tens, borrowing, if there is occasion, according to the number of tens in the higher denomination. If the value of the higher denomination be not an even number of tens, subtract the units and tens at once, borrowing according to the value of the higher denomination. It is often necessary to place the sums in different columns, in order to exhibit a clear view of what is required. For instance, if the values of several parcels of goods are to be added, and each parcel consists of several articles, the particular articles should be placed in an inner column, and the sum of each parcel extended to the outer column, and the total added there. If any person be indebted an account, and has made some partial payments, the payments must be placed in an inner column, and their sum extended under that of the account in the outer column, and subtracted there: the following examples will explain our meaning:

	L.	*s.*	*d.*
Borrowed......	25107	15	7
	375	5	5¼
Paid	259	2	7½
at	359	13	4¾
different	523	17	3
times	274	15	7¼
	325	16	5
Paid in all......	2118	7	8¾
Remains to pay	22989	7	10½

	L.	*s.*	*d.*
Lent......	550156	1	6
	171	13	7¼
Received	359	15	3
at	475	13	9¾
several	527	15	0¼
payments	272	17	5
	150	—	0

MULTIPLICATION.

In multiplication two numbers are given, and it is required to find how much the first amounts to, when reckoned as many times as there are units in the second. Thus 8 multiplied by 5, or 5 times 8, is 40. The given numbers (8 and 5) are called factors; the first (8) the multiplicand; the second (5) the multiplier; and the amount (40) the product. This operation is nothing else than addition of the same number several times repeated. If we mark 8 five times under each other, and add them, the sum is 40: but as this kind of addition is of frequent and extensive use, in order to shorten the operation, we mark down the number only once, and conceive it to be repeated as often as there are units in the multiplier. For this purpose, the learner must be thoroughly acquainted with the following multiplication table, which is composed by adding each digit 12 times.

TABLE.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

In this table the multiplicand figures are in the upper horizontal row; the multipliers are in the left hand column, and the products will be found under the multiplicand, and in the same row with the multiplier; thus 9 times 11 are 99; and 99 will be found in the column under the 11, and in the same horizontal row with the 9, among the multipliers.

If both factors be under 12, the table exhibits the product at once. If the multiplier only be under 12, we begin at the unit place, and multiply the figures in their order, carrying the tens to the higher place, as in addition.

Example.

76859 multiplied by 4

$$\begin{array}{rr} & 4 \\ \hline \text{Ans.} & 307436 \end{array}$$

or, 76859 added 4 times.

$$\begin{array}{rl} & 76859 \\ & 76859 \\ & 76859 \\ \hline \text{Ans.} & 307436 \text{ the same as before.} \end{array}$$

If the multiplier be 10, we annex a cypher to the multiplicand. If the multiplier be 100, we annex two cyphers; and so on. The reason is obvious, from the use of cyphers in notation. If the multiplier be any digit, with one or more cyphers on the right hand, we multiply by the figure, and annex an equal number of cyphers to the product.

Thus, if it be required to multiply by 60, we first multiply by 6, and then annex a cypher. It is the same thing as to add the multiplicand 60 times; and this might be done by writing the account at large, dividing the column into 10 parts of 6 lines, finding the sum of each part, and adding these ten sums together. If the multiplier consist of several significant figures, we multiply separately by each, and add the products. It is the same as if we divided a long account of Addition into parts corresponding to the figures of the multiplier.

Example.

To multiply 7329 by 365

$$\begin{array}{rrr} 7329 & 7329 & 7329 \\ 5 & 60 & 300 \\ \hline 36645 & 439740 & 2198700 \end{array}$$

$$\begin{array}{rcr} 36645 & = & 5 \text{ times.} \\ 439740 & = & 60 \text{ times.} \\ 2198700 & = & 300 \text{ times.} \\ \hline 2675085 & = & 365 \text{ times.} \end{array}$$

It is obvious that 5 times the multiplicand added to 60 times, and to 300 times, the same must amount to the product required. In practice, we place the products at once under each other; and as the cyphers arising from the higher places of the multiplier are lost in the addition, we omit them. Hence may be inferred the following

Rule. Place the multiplier under the multiplicand, and multiply the latter successively by the significant figures of the former, by placing the right-hand figure of each product under the figure of the multiplier from which it arises; then add the product.

Example.

7329	93956
365	8704
36645	375824
43974	657692
21987	751648
2675085	817793024

A number, which cannot be produced by the multiplication of two others, is called a prime number; as 3, 5, 7, 11, and many others. A number, which may be produced by the multiplication of two or more smaller ones, is called a composite number. For example, 27, which arises from the multiplication of 9 by 3; and these numbers (9 and 3) are called the component parts of 27.

1. If the multiplier be a composite number, we may multiply successively by the component parts.

Example.

7638	by 45, or 5 times 9	7638
45		9
38190		68742
30552		5
343710		343710

Because the second product is equal to five-times the first, and the first is equal to nine-times the multiplicand, it is obvious that the second product must be five-times-nine, or forty-five-times as great as the multiplicand.

2. If the multiplier be 5, which is the half of 10, we may annex a cypher, and divide by 2. If it be 25, which is the fourth part of 100, we may annex two cyphers, and divide by 4. Other contractions of the like kind will readily occur to the learner.

3. To multiply by 9, which is one less than 10, we may annex a cypher, and subtract the multiplicand from the number it composes. To multiply by 99,999, or any number of 9's, annex as many cyphers, and subtract the multiplicand. The reason is obvious; and a like rule may be found, though the unit place be different from 9. Multiplication is proved by repeating the operation, using the multiplier for the multiplicand, and the multiplicand for the multiplier. It may also be proved by division, or by casting out the 9's; of which afterwards; and an account, wrought by any contraction, may be proved by performing the operation at large, or by a different contraction.

The following examples will serve to exercise a learner in this rule.

1. Multiply 87945 by 2
2. . . . 947321 by 3
3. . . . 7914735 by 4
4. . . . 49782147 by 5
5. . . . 5721321 by 6
6. . . . 4794321 by 7
7. . . . 7654319 by 8
8. . . . 3721478 by 9
9. . . . 4783219 by 11
10. . . . 4733218 by 12
11. . . . 4783882 by 21
12. . . . 2179929 by 32
13. . . . 921577394 by 84
14. . . . 217431473 by 132
15. . . . 47314796 by 144
16. . . . 217932173 by 96
17. . . . 314731271 by 121
18. . . . 4796427 by 238
19. . . . 470621472 by 432
20. . . . 479621473 by 453
21. . . . 479632179 by 473
22. . . . 473457896 by 963
23. . . . 943446788 by 987
24. . . . 49416739 by 298
25. . . . 479327 by 403
26. . . . 4932149 by 3028
27. . . . 4731214 by 3008
28. . . . 49496 by 4009
29. . . . 97213217 by 904
30. . . . 49321729 by 706
31. . . . 4932920 by 720
32. . . . 493679310 by 970
33. . . . 7893470 by 760
34. . . . 479379340 by 900

COMPOUND MULTIPLICATION.

I. If the multiplier do not exceed 12, the operation is performed at once, beginning at the lowest place, and carrying according to the value of the place.

Examples.

L. s. d.	*cwt. qr. lb.*
13 .. 6 .. 7	12 .. 2 .. 8
9	5
119 .. 19 .. 3	62 .. 3 .. 12
A. R. P.	*lb. oz. dwt.*
13 .. 3 .. 18	7 .. 5 .. 9
6	12
83 .. 0 .. 28	89 .. 5 .. 8

II. If the multiplier be a composite number, whose component parts do not exceed 12, multiply first by one of these parts, then multiply the product by the other. Proceed in the same manner, if there be more than two.

L. *s.* *d.*
Ex. 1. 256 .. 4 .. 7½ × by 72 = 12 × 6
12
3074 .. 15 .. 6
6
Ans. 18448 .. 13 .. 0

L. *s.* *d.*
Ex. 2. 355 .. 13 .. 7¾ × 180 = 12 × 5 × 3
12
4268 .. 3 .. 9
5
21340 .. 18 .. 9
3
Ans. 64022 .. 16 .. 3

The component parts will answer in any order; it is best, however, when it can be done, to take them in such order as may clear off some of the lower places in the first multiplication, as is done in both the examples. The operation may be proved by taking the component parts in a different order, or by dividing the multiplier in a different manner.

III. If the multiplier be a prime number, multiply first by the composite number next lower, then by the difference, and add the products.

L. *s.* *d.*
Ex. 576 .. 4 .. 9½ × 87 = 12 × 7 + 3
12
6914 .. 17 .. 6
7
48404 .. 2 .. 6
1728 .. 14 .. 4½ = 3 times.
Ans. 50122 .. 16 .. 10½

Here we multiply the given sum by 12 and 7, becouse 12 × 7 = 84, the answer is 48404*l.* 2*s.* 6*d.* we then multiply the given sum by 3, which gives 1728*l.* 14*s.* 4½*d.* these sums added together give the true answer.

IV. If there be a composite number a little larger than the multiplier, we may multiply by that number, and by the difference, and subtract the second product from the first.

L. *s.* *d.*
Ex. 3276 .. 10 .. 4½ × 34 = 5 × 6 — 2
6
23861 .. 2 .. 3
6
143166 .. 13 .. 6
7953 .. 0 .. 9
Ans. 135213 .. 12 .. 9

We multiply the given sum by 6 and 6, because 6 × 6 = 36; the answer is 143166*l.* 13*s.* 6*d.* we then multiply the sum by 2, and subtracting that product from the former, we get the true answer.

V. If the multiplier be large, multiply by 10, and multiply the product again by 10; by which means you obtain an hundred times the given number. If the multiplier exceed 1000, multiply by 10 again, and continue it farther if the multiplier require it; then multiply the given number by the unit place of the multiplier; the first product by ten place, the second product by the hundred place, and so on. Add the products thus obtained together.

Examples. Multiply 35*l.* 14*s.* 8½*d.* by 4555.

L. *s.* *d.* *L.* *s.* *d.*
35 .. 14 .. 8½ × 5 = 178 .. 13 .. 6½ = 5 times.
10
357 .. 7 .. 1 × 5 = 1786 .. 15 .. 5 = 50 times.
10
3575 .. 10 .. 10 × 5 = 17877 .. 14 .. 2 = 500 times.
10
35755 .. 8 .. 4 × 4 = 143021 .. 13 .. 4 = 4000 times.
Ans. 162864 .. 16 .. 5½ = 4555 times.

The following examples will furnish the learner with practice.

1. 21 ells of Holland, at 7*s.* 8½*d. per* ell. *Ans. L*8 .. 1 .. 10½.
2. 35 firkins of butter, at 15*s.* 3½*d. per* firkin. *Ans. L*26 .. 15 .. 2½.
3. 75 *lb.* of nutmegs, at 7*s.* 2¾*d. per lb.* *Ans. L*27 . 2 .. 2¼.
4. 37 yards of tabby, at 9*s.* 7*d. per* yard *Ans. L*17 .. 14 . 7.
5. 97 cwt. of cheese, at 1*l.* 5*s.* 3*d. per* cwt. *Ans. L*122 .. 9 .. 3.
6. 43 dozen of candles, at 6*s.* 4*d. per* doz. *Ans. L*13 .. 12 .. 4.
7. 127 *lb.* of bohea tea, at 12*s.* 3*d. per lb.* *Ans. L*77 .. 15 .. 9.
8. 135 gallons of rum, at 7*s.* 5*d. per* gallon. *Ans. L*50 .. 1 .. 3.
9. 74 ells of diaper, at 1*s.* 4½*d. per* ell. *Ans. L*5 .. 1 .. 9.

The use of multiplication is to compute the amount of any number of equal articles, either in respect of measure, weight, value, or any other consideration. The multiplicand expresses how much is to be reckoned for each article, and the multiplier expresses how many times that is to be reckoned. As the multiplier points out the number of articles to be added, it is always an abstract number, and has no reference to any value or measure whatever. It is therefore quite improper to attempt the multiplication of shillings by shillings, or to consider the multiplier as expressive of any denomination. The most common instances, in which the practice of this operation is required, are to find the amount of any number of parcels, to find the value of any number of articles, to find the weight or measure of a number of articles, &c. This computation for changing any sum of money, weight, or measure, into a different kind, is called Reduction. When the quantity given is expressed in different denominations, we reduce the highest to the next lower, and add thereto the given number of that denomination; and proceed in like manner till we have reduced it to the lowest denomination.

Ex. Reduce 58*l.* 4*s.* 2½*d.* into farthings.

58 .. 4 .. 2½
20
1164 = shillings in *L*58 .. 4.
12
13970 = pence in *L*58 .. 4 .. 2.
4
Ans. 55882 = farthings in *L*58 .. 4 .. 2½

DIVISION.

In division two numbers are given, and it is required to find how often the former contains the latter. Thus it may be asked how often 21 contains 7, and the answer is exactly 3 times. The former given number (21) is called the dividend; the latter (7) the divisor; and the number required (3) the quotient. It frequently happens that the division cannot be completed exactly without fractions. Thus it may be asked, how often 8 is contained in 19? the answer is, twice, and the remainder of 3. This operation consists in subtracting the division from the dividend, and again from the remainder, as often as it can be done, and reckoning the number of subtractions. As this operation, performed at large, would be very tedious, when the quotient is a high number, it is proper to shorten it by every convenient method; and, for this purpose, we may multiply the divisor by any number whose product is not greater than the dividend, and so subtract it twice or thrice, or oftener, at the same time. The best way is, to multiply it by the greatest number, that does not raise the product too high, and that number is also the quotient. For example, to divide 45 by 7, we inquire what is the greatest multiplier for 7, that does not give a product above 45; and we shall find that it is 6; and 6 times 7 is 42, which, subtracted from 45, leaves a remainder of 3. Therefore 7 may be subtracted 6 times from 45; or, which is the same thing, 45 divided by 7, gives a quotient of 6, and a remainder of 3. If the divisor do not exceed 12, we readily find the highest multiplier that can be used from the multiplication table. If it exceed 12, we may try any multiplier that we think will answer. If the product be greater than the dividend, the multiplier is too great; and if the remainder, after the product is subtracted from the dividend, be greater than the divisor, the multiplier is too small. In either of these cases we must try another. But the attentive learner, after some practice, will generally hit on the right multiplier at first. If the divisor be contained oftener than ten times in the dividend, the operation requires as many steps as there are figures in the quotient. For instance, if the quotient be greater than 100, but less than 1000, it requires three steps.

Example. Divide 48764312 by 9.

9)48764312
Ans. 5418256—8 remainder.
9
Proof 48764312

In this example we say the 9's in 48, 5 times and 3 over; put down 5 and carry 3, and say 9's in 37, 4 times and 1 over; put down 4 and carry 1; 9's in 16, 1 and 7 over; and so on to the end; there is 8 over as a remainder. The proof is obtained by multiplying the quotient by the divisor, and taking in the remainder; this is called "Short Division," of which we give for practice the following examples.

1. Divide 4732157 by 2
2. . . 342351742 by 3
3. . . 435234174 by 4
4. . . 49491244 by 5
5. . . 94942484 by 6
6. . . 4434983 by 7
7. . . 994357971 by 8
8. . . 449246812 by 9
9. . . 557779991 by 11
10. . . 665594765 by 12

The second part of this rule is called "Long Division," for the practice of which we give these directions.

Count the same number of figures on the left of the dividend as the divisor has in it; try whether the divisor be contained in this number; if not contained therein, take another dividend figure, and then try how many times the divisor is contained in it.

To find more easily how many times the divisor is contained in any number; cast away in your mind all the figures in the divisor, except the left hand one, and cast away the same number from the dividend figures as you did from the divisor: the two numbers, being thus made small, will be easily estimated.

If the product of the divisor with the quotient figure be greater than the number from which it should be taken, the number thought of was too great, the multiplying must be rubbed out, and a less quotient figure used.

When, after the multiplying and subtracting, the remainder is more than the divisor, the quotient figure was too small, the work must be rubbed out, and a larger number supplied.

Example.

Divide 87654213, by 987.

987)87654213(88808 Quotient.
7896
.8694
7896
.7982
.7896
.8613
.7896
.717 remainder.

88808
987
621663
710465
799279
87654213 proof.

Ans. $88808\frac{717}{987}$

To prove the truth of the sum, I multiply the quotient by the divisor, and take in the remainder, which gives the original dividend.

Examples for Practice.

1. Divide 721354 by 21
2. . . 57214372 by 42
3. . . 67215731 by 63
4. . . 802594321 by 84
5. . . 965314162 by 89
6. . . 43219875 by 674
7. . . 57397296 by 714
8. . . 496521 by 2798
9. . . 49446327 by 796
10. . . 47324967 by 699
11. . . 275472734 by 497
12. . . 43927483 by 586
13. . . 96543245 by 763
14. . . 25769782 by 469

A number that divides another without a remainder is said to measure it, and the several numbers that measure another are called its aliquot parts. Thus 3, 6, 9, 12, 18, are the aliquot parts of 36. As it is frequently necessary to discover numbers which measure others, it may be observed, 1. That every number ending with an even number, that is, with 2, 4, 6, 8, or 0, is measured by 2. 2. Every number, ending with 5 or 0, is measured by 5. 3. Every number, whose figures, when added, amount to an even number of 3's or 9's, is measured by 3 or 9 respectively.

In speaking of the contractions and variety in division, we have already seen, that when the divisor does not exceed 12, the whole computation may be performed without setting down any figure except the quotient.

When the divisor is a composite number, we may divide successively by the component parts: thus, if 678450 is to be divided by 75, we may either perform the operation by long division, or divide by 5, 5, and 3, because 5 × 5 × 3=75.

Where there are cyphers annexed to the divisor, cut them off, and cut off also an equal number of figures from the dividend; annex these figures to the remainder.

Example.

Divide 54234564 by 602400

$$6024{,}00)542345{,}64(90\tfrac{18564}{602400}$$
$$\underline{54216}$$
$$...18564$$

To divide by 10, 100, 1000, &c. Cut off as many figures on the right hand of the dividend as there are cyphers in the divisor. The figures which remain on the left hand compose the quotient, and those cut off compose the remainder.

Example.

Divide 594256 by 1000.

1,000)594,256

Ans. $594\tfrac{256}{1000}$.

When the divisor consists of several figures, we may try them separately, by enquiring how often the first figure of the divisor is contained in the first figure of the dividend, and then considering whether the second and following figures of the divisor be contained as often in the corresponding ones of the dividend with the remainder, if any prefixed. If not, we must begin again, and make trial of a lower number.

We may form a table of the products of the divisor multiplied by the nine digits, in order to discover more readily how often it is contained in each part of the dividend. This is always useful, when the dividend is very long, or when it is required to divide frequently by the same divisor.

Example.

Divide 689543271 by 37.

37 × 2= 74
3=111
4=148
5=185
6=222
7=259
8=296
9=333

37)689543271(18636304
37
319
226
. 235
222
. 134
111
. 233
222
112
111
171
148
. 23

As multiplication supplies the place of frequent additions, and division of frequent subtraction, they are only repetitions and contractions of the simple rules, and when compared together, their tendency is exactly opposite. As numbers increased by addition are diminished and brought back to their original quantity by subtraction, in the same manner numbers compounded by multiplication are reduced by division to the parts from which they are compounded. The multiplier shews how many additions are necessary to produce the number, and the quotient shows how many subtractions are necessary to exhaust it. Hence it follows, that the product divided by the multiplicand will give the multiplier; and because either factor may be assumed for the multiplicand, therefore the product divided by either factor gives the other. It also follows, that the dividend is equal to the product of the divisor and quotient multiplied together, and of course these operations mutually prove each other.

To prove Multiplication. Divide the product by either factor; if the operation be right, the quotient is the other factor, and there is no remainder.

To prove Division. Multiply the divisor and quotient together; to the product add the remainder, if any; and if the operation be right, it makes up the dividend.—We proceed to

COMPOUND DIVISION.

For the operation of which the rule is: when the dividend only consists of different denominations, divide the higher denomination, and reduce the remainder to the next lower, taking in the given number of that denomination, and continue the division. When the divisor is not greater than 12, we proceed as before in short division.

Examples.

L. *s.* *d.*   *L.* *s.* *d.*
5)84 .. 3 .. 9   11)976 .. 13 .. 7$\frac{1}{4}$
Ans. 16 16 9   Ans. 88 15 9$\frac{1}{4}$—8

lb. *oz.* *dwts.*   *cwt.* *qr.* *lb.* *oz.*
8)994 .. 4 .. 8   12)45 .. 2 .. 18 .. 8
124 .. 3 .. 11   3 .. 3 .. 6 .. 3 .. 5—4

When the divisor is greater than 12, the operation is performed by long division.

Example.

L. *s.* *d.*
Divide 8467 .. 16 .. 8 by 659.

L. *s.* *d.*
659)8467 .. 16 .. 8(12
659
1877
1318
. 559
20
659)11196(16
659
4606
3954
. 652
12
659)7832(11
7249
583
4
659)2332($\frac{3}{4}$
1977
. 353

Ans. 12 .. 16 .. 11$\frac{3}{4}\frac{353}{659}$.

In connection with the rule of division, we may notice another kind of Reduction, so called, though improperly, as by it is meant to bring smaller denominations into larger; as pence into pounds, or drams into hundred weights, &c.; for which the rule is: divide by the parts of each denomination from that given to the highest sought: the remainders, if any, will be of the same name as the quantity from which they were reduced.

Examples.

1. In 415684 farthings, how many pounds sterling.

4)415684
12)103921
2,0)866,0–1
Ans. *l.*433 .. 0 .. 1

2. How many pounds troy are there in 67890 dwts.

2,0)6789,0
12)3394 – 10
282 .. 10 .. 10.

lb. *oz.* *dwts.*
Ans. 282 .. 10 .. 10.

Before we conclude this article we may observe, that in computations which require several steps, it is often immaterial what course we follow. Some methods may be preferable to others, in point of ease and brevity; but they all lead to the same conclusion. In addition or subtraction, we may take the articles in any order. When several numbers are to be multiplied together, we may take the factors in any order, or we may arrange them into several classes; find the product of each class, and then multiply the products together. When a number is to be divided by several others, we may take the divisors in any order, or we may multiply them into one another, and divide by the product; or we may multiply them into several parcels, and divide by the products successively. Finally, when multiplication and division are both required, we may begin with either; and when both are repeatedly necessary, we may collect the multipliers into one product, and the divisors into another; or we may collect them into parcels, or use them singly; and that in any order. To begin with multiplication is generally the better mode, as this order preserves the account as clear as possible from fractions.

We have hitherto given the most ready and direct method of proving the foregoing examples, but there is another, which is very generally used, called "casting out the 9's," which depends on this principle: That if any number be divided by 9, the remainder is equal to the remainder obtained, when that sum is divided by 9. For instance, if 87654 be divided by 9, there is a remainder of 3; and if 8, 7, 6, 5, 4, be added together, and the sum 30 be divided by 9, there will be likewise a remainder of 3.

To cast out the 9's of any number, add the figures, and when the sum is equal to or more than 9, pass by the 9, and proceed with the remainder: thus, in casting out the 9's of 56774 we say 5 and 7 are 12, 3 above 9; 3 and 7 are 10, 1 above 9, 1 and 7 are 8; 8 and 4 are 12, 3 above 9: the last remainder is to be put down, and then proceed to the other lines, according to the following rules.

To prove Addition. Cast out the 9's of the several articles, carrying the results to the following articles, and cast them out of the sum total; if the operations be correct, the two remainders, if any, will agree.

Example. 845
346
784
Sum 1975

Here, in casting out the 9's of the three lines to be added, I find a remainder of 4; there is also a remainder of 4 upon casting out the 9's of the sum.

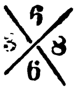
To prove Subtraction. Cast the 9's out of the minuend; then cast them out of the subtrahend and remainder together, and if the same result is obtained in both cases, the operation may be regarded as accurate.

Example. 59876
34959
24917

In casting out the 9's of the upper row, I find the remainder 8, the same is found in casting out the 9's of the two lower lines.

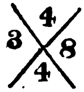
To prove Multiplication. Cast the 9's out of the multiplicand, and put the remainder on one side of a cross, then do the same with the multiplier, and put the remainder on the other side of the cross; multiply these remainders together, and cast the 9's out of the product, the remainder place at the top of the cross; cast the 9's out of the product, and the remainder place at the bottom of the cross, which, if the operation be correct, will be the same as that at the top.

Example. 5943
26
25658
11886
154518



To prove Division. Cast the 9's out of the divisor, and also out of the quotient, the remainder of the former place on the side of the cross; that of the latter on the other; multiply them together, and take in the remainder, if any; cast out the 9's, and the remainder put at the top of the cross; this, if the operation be correct, will agree with the remainder of the dividend obtained from the dividend after the 9's are cast out.

Ex. 264) 87655 (332
792
.845
792
.535
528
..7



This method of proving sums lies under disadvantages. 1. If an error of 9, or any of its multiples, be committed, the results will nevertheless agree, and so the error will remain undiscovered. This will be the case, when a figure is placed or reckoned in a wrong column, which is a frequent cause of mistake. 2. When it is known that an error has been committed, it is not pointed out where the error lies, and of course not easily corrected.

Having given a full account of the fundamental rules of Arithmetic, we shall refer our readers to the several articles in alphabetical order, for rules depending on the four already treated on. See ALLIGATION, ANNUITIES, EXCHANGE, INTEREST, &c. &c.

ARITHMETICAL *complement of a logarithm*, the sum or number which a logarithm wants of 10,000,000: thus the arithmetical complement of the logarithm 8.154032 is 1.845968.

ARM, a part of the human body, terminating at one end in the shoulder, and at the other in the hand. See ANATOMY.

ARMADA, a Spanish term, signifying a fleet of men of war; it is more particularly applied to the ships by which an attempt was made by Philip II. of Spain, to invade England, in the reign of Queen Elizabeth, A. D. 1588. This expedition was excited as well by the injuries which the king had sustained from the English arms, as with a view of transmitting his name to posterity, as the defender of the true faith. In the preceding year, a whole fleet of transports was destroyed at Cadiz by Drake, who ravaged the Spanish coast. Cavendish, another sea commander, committed, about the same time, great depredations on the Spaniards in the South-Sea, taking 19 vessels richly laden, with which he entered, in triumph, the river Thames. On these, and other accounts not less mortifying to the pride of Spain, Philip looked for speedy and ample revenge, by the overthrow of the power and credit of Elizabeth, who was every where regarded as the protector and bulwark of the Protestant religion. These preparations were conducted with secrecy, but with all the vigour of which he was capable. His ministers, admirals, and generals, were employed in the business; and measures were taken, not only in Spain, but in the ports of Sicily, Naples, and Portugal, for fitting out a most tremendous fleet. In Flanders also there were considerable military preparations; and an army of 14,000 men was assembled in the Netherlands, which was kept in readiness to embark, in flat-bottomed vessels constructed for the occasion. To the most renowned nobility, and princes of Italy and Spain, who were ambitious of being enrolled among the conquerors of England, were added many hundreds of English desperadoes, under the conduct of a man who had been banished for selling a Dutch fortress to Spain.

It was hoped that England would not understand, till it was too late, that these efforts were directed against her peace and existence as a nation; but the queen was never without secret intelligence of whatever was carrying on in the different parts of the Continent. The spies employed on this, and on every other occasion during her reign, were priests, it being a favourite maxim with her minister, Walsingham, that an active but vicious priest was the best spy in the world.

Elevated with the prospect of certain success, the Spaniards denominated their navy, collected for this purpose, "The Invincible Armada." The forces of England seemed to be unequal to the contest; nevertheless Elizabeth scorned to fear; her mind was in every respect adequate to the greatness of the cause. At that period the number of sailors in this country amounted to 14,000, and the navy to only 28 sail, many of which were small in size, and of no great force. The seamen indeed were very superior to those of the enemy with whom they had to contend, which compensated in some measure for the inferiority of the size and force of their vessels. The attachment to their religion and liberties roused the exertions of the English: London supplied 30 ships and 10,000 men, and other places imitated the example. The nobility and gentry, among whom were several Roman Catholics of distinction, united to oppose this conspiracy; they hired, armed, and manned upwards of 40 ships at their own private charge, and the money which the queen demanded by way of loans was cheerfully and readily granted. The command of the navy was entrusted to Lord Howard of Effingham; the principal fleet was stationed at Plymouth, and a smaller squadron of 40 vessels, commanded by Lord Seymour, lay off Dunkirk. An army of 20,000 men was disposed in different bodies along the coast, and a like number, with 1000 horse, under the command of the Earl of Leicester, was stationed at Tilbury, in order to defend the capital. The main army, of nearly 40,000 men, were placed under the command of Lord Hunsdon, ready to defend the queen's person, or to march wherever the enemy should appear. The King of Scotland avowed his adherence to Elizabeth, and his readiness to march his whole force, if necessary, to her aid. From Denmark and the Hanse-towns, she likewise received some help. The Protestants in general throughout Europe were anxious for the success of England. On the 29th of May, the Spanish fleet set sail from Lisbon, but on the 30th it was dispersed by a violent storm. As soon, however, as it could be refitted, it made towards the English coast, consisting of 130 vessels. These preparations had been delayed a whole year, by a circumstance mentioned by Bishop Burnet, and which is referred to in the "Acta Regia" as one of the most curious passages in the English history. "When it seemed," says the historian, "impossible to divert the present execution of so great a design, and there was no strength ready to resist it, a merchant of London effected it by this means. Being very well acquainted with the revenue and expense of Spain, and all that they could do, and knowing that their funds were so swallowed up, that it was impossible for them to victual and fit out their fleet, but by their credit on the bank of Genoa, he undertook to write to all the places of trade, and to get such remittances made on that bank, that he might have so much of the money in his own hands, that there should be none current there equal to the great occasion of victualling the Spanish fleet. He reckoned the keeping of such a treasure dead in his hands till the season of victualing was over would be a loss of 40,000*l.* He managed the matter with such secrecy and success, that the fleet could not be set out that year; at so small a price, and with so skilful a management, says the bishop, was the nation saved at that time." On the 19th of July the famous armada arrived in the Channel, disposing itself in the form of a crescent, and stretching to the distance of seven miles from the extremity of one division to that of the other. As it proceeded up the Channel, Effingham, with the English fleet, gave orders to avoid a close fight, but to skirmish with the larger ships of the Spanish fleet, which it continued to do for six days. The armada, having reached Calais, cast anchor, and waited the arrival of the Prince of Parma, who delayed leaving the Flemish ports until he was assured that the Spaniards were masters of the sea. While the Spanish fleet lay confusedly in this position, the English Admiral, by a successful stratagem, dispatched several of his smaller ships filled with combustibles into the midst of the enemy, and thus alarmed them to such a degree, that they immediately cut their cables, and betook themselves to flight in the greatest disorder and precipitation. The English fleet pursued them and took several ships. A violent tempest then assailed the armada, after it had passed the Orkneys, and most of the vessels that had escaped from the battle were driven on the western isles of Scotland, or on the coast of Ireland, where they were miserably wrecked. Such was the termination of this desperate attempt against the liberties of our country: the foregoing account of which, in a scientific point of view, exhibits the state of naval tactics at that period of our history, and various other topics, interesting to the English reader.

ARMILLARY *sphere*, an artificial sphere, composed of a number of circles, representing the several circles of the mundane sphere, put together in their natural order, to ease and assist the imagination in conceiving the constitution of the heavens, and the motions of the celestial bodies.

The armillary sphere, constructed about 30 years since by Dr. Long, of Cambridge is 18 feet in diameter, and will conveniently contain 30 persons, who may sit within it, to view, as from a centre, the representation of the celestial sphere. That part of the sphere, which to the inhabitants of these kingdoms never rises above the horizen, is cut off, and the whole is so well contrived and adapted, that it turns round with very little labour.

ARMINIANS, in church history, a sect of christians which arose in Holland, by a separation from the Calvinists. They are great asserters of free-will. They speak very ambiguously of the prescience of God. They look on the doctrine of the Trinity as a point not necessary to salvation; and many of them hold there is no precept in scripture, by which we are enjoined to adore the Holy Ghost; and, that Jesus is not equal to God the Father.

They take their name from Arminius, a disciple of Beza, whose tenets may be thus enumerated: 1. That God has not fixed the future state of mankind by an absolute unconditional decree; but determined from all eternity to bestow salvation on those, whom he foresaw would persevere to the end in their faith in Christ, and to inflict punishment on those who should continue in their unbelief, and resist to the end his divine assistance. 2. That Jesus Christ, by his death and sufferings, made an atonement for the sins of mankind in general, and for every individual in particular; that, however, none but those who believe in him can be partakers of this divine benefit. 3. That mankind are not totally depraved, and that depravity does not come upon them by virtue of Adam's being their public head, but that mortality and natural evil only are the direct consequences of his sin to posterity. 4. That there is no such a thing as irresistible grace in the conversion of sinners: and 5. That those who are united to Christ by faith, may fall from their faith, and finally forfeit their state of grace. Dr Whitby, an eminent divine of the Church of England, has written a long defence of this doctrine; to this may be noticed, Dr. Taylor's "Key to the epistle to the Romans." Among the modern writers, Mr. John Wesley, and Mr. Fellowes, in his "Religion without Cant," and in his "Christian Philosophy," have ably advocated the cause of Arminianism.

ARMONICA. See HARMONICA.

ARMORY is a branch of the science of heraldry, consisting in the knowledge of coats of arms, as to their blazons and various intendments.

ARMOUR denotes all such habiliments as serve to defend the body from wounds especially of darts, a sword, a lance, &c. A complete suit of armour formerly consisted of a helmet, a shield, a cuirasse, a coat of mail, a gauntlet, &c. all now laid aside.

ARMS, in general, all kinds of weapons, whether used for offence or defence.

Arms *and Ammunition*, no merchant vessel is allowed to carry more than two carriage guns of 4 pounds calibre, nor more than in the proportion of two musquets for every ten men, except ships of marc, or vessels employed in the service of the victualling, ordnance, customs, excise, or post office, without being regularly licensed for that purpose.

Arms or Armories, in heraldry, marks of honour borne upon shields, banners, and coats, in order to distinguish states, families and persons.

At this time, arms follow the nature of titles, which being made hereditary, they are also become so, being the several marks to distinguish families, as names serve to distinguish individuals They are the gift of kings and princes, through the ministry of their kings and heralds of arms, who ought to be knowing and judicious, to give the proper arms to all persons.

ARMY, a large body of soldiers, consisting of horse and foot, completely armed, and provided with artillery, ammunition, provisions, &c. under the command of one general, having lieutenat-generals. major-generals, brigadiers and other officers under him. An army is composed of squadrons and battalions, and is usually divided into three corps, and formed into three lines; the first line is called the van-guard, the second the main body and the third the rear-guard, or body of reserve. The middle of each line is possessed by the foot, the cavalry form the right and left wing of each line; and sometimes they place squadrons of horse in the intervals between the battallions. When the army is drawn up in order of battle, the horse are placed at five feet distance from each other, and the foot at three. In each line the battalions are distant from each other one hundred and eighty feet, which is nearly equal to the extent of their front; and the same holds of the squadrons, which are about three hundred feet distant, the extent of their own front. These intervals are left for the squadrons and battalions of the second line to range themselves against the intervals of the first, that both may more readily march through those spaces to the enemy: the first line is usually three hundred feet distant from the second, and the second from the third, that there may be sufficient room to rally, when the squadrons and battalions are broken.

Our armies anciently were a sort of militia, composed chiefly of the vassals and tenants of the lords. When each company had served the number of days or months enjoined by their tenure, or the customs of the fees they held, they returned home. Armies are distinguished by the appellations of a covering army, designed to protect the different passes which lead to a principal object of defence: a blockading army, which is provided with heavy ordnance and other warlike means, and is employed to invest a town, for the direct and immediate purpose of reducing it by assault or famine: an army of observation, so called, because, by its advanced positions and desultory movements, it is constantly employed in watching an army: an army of reserve, which is a general depot of effective service;—in cases of emergency, the whole or detatched parts of an army of reserve are employed to recover a lost day, or to secure a victory; and a flying army, which is mostly a strong body of horse and foot, always in motion, both to cover its own garrison, and to keep the enemy in continual alarm.

ARNICA, in botany, a genus of plants of the Syngenesia Superflua class and order. Essen. char. receptacle naked; down simple; calyx equal; florets of the margin generally with five filaments destitute of antheræ. There are 24 species.

ARNOPOGON, a genus of the Syngenesia Æqualis class and order.. Receptacle naked; down feathery, on a pedicle; calyx one-leafed, eight-parted, turbinate. There are four species.

AROMA, is that part of odorous bodies which affects the organs of smell, and is supposed by some to be a peculiar principle.

ARRAC, a spirituous liquor imported from the East Indies, and obtained by distillation from rice or sugar, fermented with the juice of cocoa nuts.

ARRAGONITE, a mineral, first found in Arragon, imbedded in gypsum; afterwards in the Pyrenees, and at Salzburgh. Colour greenish and pearl-grey; in the middle often violet and green. Always crystallized in regular six-sided prisms. Fracture between imperfect, foliated, and fibrous. Colour arranged in the direction of the fibres; the longitudinal fibres green; the transverse violet-blue, brittle; specific gravity 2.94. It effervesces with acids, and from its resemblance to appatite, Werner is of opinion that it may contain a small portion of phosphoric acid; but neither Klaproth nor Thenard have been able to detect in it any thing but lime and carbonic acid. It is found in France, and in the Pyrenean mountains. Its specific gravity makes it intermediate between calc-spar and appatite.

ARRAIGNMENT, in law, the arraigning or setting a thing in order, as a person is said to arraign a writ of novel disseisin, who prepares and fits it for trial. It is most properly used to call a person to answer in form of law upon an indictment, &c. at the suit of the king.

The arraignment is to take care that the prisoner appears to be tried, and hold up his hand at the bar, for the certainty of the person, and plead a sufficient plea to the indictment. The prisoner is to hold up his hand only in treason and felony; but this is only a ceremony: if he owns that he is the person, it is sufficient without it; and then, upon his arraignment, his fetters are to be taken off. A prisoner under indictment of the highest crime must be brought to the bar without irons, shackles, or bonds. This is the law; but, to the disgrace of our courts, it is almost wholly disregarded, and prisoners are generally tried in their irons.

ARRANGEMENT, in music, is that extension, selection, and disposal of the movements and parts of a composition, which fit and accommodate it to the powers of some instrument or instruments for which it was not originally designed by the composer.

ARREARS, the remainder of a sum due, or money remaining in the hands of, an accountant. It signifies also, more generally, the money that is due for rent unpaid for land or houses; likewise what remains unpaid of pensions, taxes, or any other money payable annually, or at any fixed term.

ARREST, in civil cases, is a legal restraint of a person charged with some debt to an individual; and, in criminal cases, for some crime against the state; and it is executed in pursuance of the command of some court of record, or officer of justice. Certain persons are privileged from arrests, as members of parliament, peeresses by birth, marriage, &c., members of convocation actually attending them, ambassadors, domestic servants of ambassadors, king's servants, marshals, or wardens of the fleet, clerks, attornies, or other persons attending the courts of justice, clergymen performing divine service, suitors, witnesses supœnaed, and other persons necessarily attending any court of record upon business, bankrupts coming to surrender, within 42 days after their surrender, witnesses properly summoned before commissioners of bankruptcy, or other commissioners of great seal: sailors and volunteer soldiers, unless the debt be 20*l.*, officers of court, only where they are sued in their rights, but not if as executors or administrators, nor in joint actions. No writ, process, warrant, &c. (except for treason, felony, or for breach of the peace), shall be served on Sunday; but a person arrested the day before may be retaken on the Sunday. No person can be arrested out of a superior court, unless the cause of action be 10*l.* and upwards; an arrest must be by corporal seizing, or touching the defendant. An officer cannot justify breaking open an outward door or window to execute process, unless a stranger, who is not of the family, upon a pursuit, take refuge in the house of another. The chamber of a lodger is not to be considered as his outer door. No officer shall carry his prisoner to any tavern without his consent, nor to goal within 24 hours after his arrest, unless he refuses to go to some safe house. In criminal cases, the causes of suspicion which justify the arrest of a person for felony are, the common fame of the country, the living a vagrant, idle, disorderly life, without any visible means to support it; the being in company with a known offender at the time of the offence; the being found in circumstances which induce a strong presumption of guilt; behaviour betraying a consciousness of guilt; and the being pursued by hue and cry. But none of these causes will justify the arresting a man for the suspicion of crimes, unless a crime has been actually committed.

Arrest *of judgment:* to move in arrest of judgment, is to shew cause why judgment should not be stayed, notwithstanding a verdict given. The causes of arrest of judgment are, want of notice of trial; where the plaintiff before trial treats the jury; the record differs from the deed pleaded; for material defect in pleading; where persons are misnamed; more is given and found by the verdict than laid in the declaration; or, the declaration doth not lay the thing with certainty.

ARRONDEE, in heraldry, a cross, the arms of which are composed of sections of a circle not opposite to each other, so as to make the arms bulge out thicker in one part than another: but the sections of each arm lying the same way, so that the arm is every where of an equal thickness, and all of them terminating at the edge of the escutcheon, like the plain cross.

ARSENAL, in military affairs, in a large and well fortified town, is a spacious building, in which are deposited all kinds of arms, and other warlike implements, such as cannon, mortars, howitzers, small arms, and every other warlike kind of engines and instruments of death.

ARSENIATES, in chemistry, a genus of salts, formed from arsenic acid and some particular base; thus we have the arseniates of potash, the arseniates of soda, lime, &c. They are distinguished by the following property: when heated with charcoal powder, they are decomposed, and the arsenic sublimes. These salts have not hitherto been applied to any useful purpose, and have at present been but superficially examined.

ARSENIC, in mineralogy, one of the metals that are brittle and easily fused. The word occurs first in the works of Dioscorides, and other authors, who wrote about the beginning of the Christian æra; it denotes in their works the same substance which Aristotle had called σανδαραχη, which is a reddish-coloured mineral, composed of arsenic and sulphur, used by the ancients in painting and as a medicine.

Arsenic, as it is to be found in the shops, occurs in the state of a white oxide, from which the metal may be obtained by the following process. Mix two parts of the white oxide with one part of black flux (prepared by detonating in a crucible one part of nitre with two of crystals of tartar), and put the mixture into a crucible. Invert over this another crucible; lute the two together, by a mixture of clay and sand, and apply a red heat to the lower one. The arsenic will be reduced, and will be found lining the inside of the upper crucible, in a state of metallic brilliancy. Arsenic is oxidized by mere exposure to the atmosphere. It soon becomes tarnished, loses its metallic lustre, and is changed into a blackish oxide. It is readily fusible, and is volatilized at 356°. In close vessels it may be collected unchanged; but when thrown on a red hot iron, it burns with a blue flame and a white smoke, and a strong smell of garlic is perceived. All the mineral acids act on arsenic; but not considerably, unless they are heated. In the oxigenized muriatic acid gas, however, arsenic burns vehemently. A mixture of oxymuriate of potash and arsenic furnishes a detonating compound, which takes fire with the rapidity of lightning. The salt and metal, first separately powdered, may be mixed by the gentlest possible triture, or rather by stirring them together on paper with a knife point. If two long trains be laid on a table, the one of gunpowder, and the other of this mixture, and they be in contact with each other at one end, so that they may be fired at once, the arsenical mixture burns with the rapidity of lightning, while the other burns with comparatively extreme slowness. Arsenic has the property of giving a white stain to copper. Let a small bit of metallic arsenic be put between two small plates of copper; bind these closely together with iron wire, and heat them barely to redness in the fire. The inside of the copper plates will be stained white. The white oxide of arsenic has the following properties: 1. It has an acrid taste, and is highly poisonous, 2. It is soluble in water, which, at the ordinary temperature, takes up 1-80th. According to La Grange, it is soluble in 1-24th of cold water, or 1-15th of hot. 3. Oxide of arsenic combines with the pure alkalies to saturation; and hence it fulfils one of the principal functions of an acid. It has therefore been called arsenous acid, and its compounds arsenites. They may be formed by simply boiling the acid with a pure alkaline solution. 4. The arsenous acid, by distillation with sulphur, affords either a yellow substance, called orpiment, or a red one, termed realgar. Both these compounds are sulphuretted oxides of arsenic, varying in the proportion of their components. The hydro-sulphurets also throw down a yellow precipitate from solutions of arsenous acid. Sulphate of copper, mixed with arsenite of potash, gives a beautiful precipitate, called, from its discoverer, Scheele's green. 5. By repeated distillation with nitric acid, arsenous acid is changed into arsenic acid. The same change is effected also by exposure to the vapour of oxigenized muriatic acid, and the expulsion, by heat, of the common muriatic acid. By both these processes, a white concrete substance is obtained, termed arsenic acid. The arsenic acid has a sour, and at the same time a metallic, taste. It reddens vegetable blues, attracts humidity from the atmosphere, and effervesces strongly with solutions of alkaline carbonates. With alkalies, earths, and oxides, it constitutes a class of salts called arsenates. The arsenate of potash may be obtained in a more simple manner, by detonating, in a crucible, a mixture of nitrate of potash with arsenous acid. When tin is dissolved in arsenous acid, an inflammable gas is disengaged, as was observed by Scheele, consisting of hydrogen gas holding arsenic in solution. It may be obtained also by adding powdered metallic arsenic to a mixture of diluted sulphuric acid and zinc filings.

Arsenic *acid*. } See Arsenic.
Arsenious *acid*. }

ARSENITES, a name given by Fourcroy to the combinations formed between white oxide of arsenic, or arsenious acid, as he calls it, and the alkalies and earths. They were formerly termed livers of arsenic, from some fancied resemblance which was traced between arsenic and sulphur. The alkaline arsenites may be prepared by dissolving the white oxide in alkaline solutions. They do not crystallize: heat decomposes them by subliming the oxide, and almost all the acids precipitate the arsenic in the form of a white powder. The earthy arsenites, as far as they have been examined, are insoluble powders, which is the reason why white oxide of arsenic occasions a precipitate, when dropped into lime, barytes, or strontian water.

ARSON, is house burning, and burning the house of another is felony. Cr. Law, Case 143. It must be maliciously and voluntarily, and an actual burning; not putting fire only into a house, or any part of it, without burning; but if part of the house be burnt, or if the fire do burn, and then go out of itself, it is felony. 2 Inst. 188. But it is not felony to burn a house (unless done with a fraudulent intent) of which the offender is in possession, by virtue of a written agreement, for a lease of three years. Cr. Law, 143. If any servant, through carelessness, shall fire any house or out-house, and be thereof convicted, on the oath of one witness, before two justices, he shall forfeit one hundred pounds to the churchwardens of the parish where the fire shall happen, to be by them distributed to the sufferers; and, on non-payment thereof immediately on demand, the said justice shall commit him to some house of correction for eighteen months, to be there kept to hard labour.

The punishment of arson was death by our ancient Saxon laws. And in the reign of Edward I. this sentence was executed by a kind of "lex talionis," for the incendiaries were burnt to death, as they were also by the Gothic constitutions. The statute 8 Hen. VI. c. 6, made the wilful burning of houses, under some special circumstances therein mentioned, amount to the crime of high treason. But it was again reduced to felony, by the general acts of Edward VI. and Queen Mary; and now the punishment of all capital felonies is uniform, namely, by hanging. The offence of arson was denied the benefit of clergy by 31 Hen. VIII. c. 1; but that statute was repealed by 1 Edw. VI. c. 12; and arson was afterwards held to be ousted of clergy, with respect to the principal offender, only by inference and deduction from the statute 4 and 5 P. and M. c. 4.; which expressly denied it to the accessary before the fact: though even it is expressly denied to the principal, in all cases within the statute 9 Geo. I. c. 22.

ART *and Part*, in the law of Scotland, is applied to an accomplice.

The facts inferring art and part need not be particularly laid in the libel or indictment, for these general words, as terms of stated signification, are sufficient. Yet these facts may be set forth, and it is proper so to do, if the prosecutor chuses to confide in the court rather than in the jury.

Also in the criminal letters, the persons of the accomplices must be described by proper names and designations.

One may be art and part, 1. By giving counsel to perpetrate without distinction whether the crime would have been committed without such council or not, this being what can never be perfectly known. But it is to be observed, that in the more atrocious crimes, he that gives counsel is equally punished as he that commits them; but in the less atrocious, less severely. And sometimes reasons of mitigation are taken from the age, the manner of advising, &c. 2. By aid and assistance, and that either previous, or concomitant, or subsequent, to the commission of the crime. The first rarely comes up to art and part, unless very particularly qualified; the second commonly does, and it is easily known, if it does not; the third never, and hardly deserves the name, unless it be in providing for the criminal's escape. But any of the three make art and part, if the perpetration was premeditated. 3. By a clear and explicit mandate to commit the crime, or to do somewhat unlawful in it itself, which with great probability might produce it, if executed by the hand of the mandatory, and not that of another.

ARTEDIA, a genus of the Pentandria Dyginia class of plants, the general umbel of which is multiple, plane, and patent; the partial umbel is small, but similar: the general involucrum is composed of about ten leaves; they are of an oblong oval figure, nearly of the length of the umbel, and have three spines or setæ at their extremities: the partial involucrum is composed of two or three leaves, and turns outward: the general corolla is difform, and radiated; the single flowers of the disk are all males, they consist each of five erect inflexo-cordate petals; the single flowers of the radius are all hermaphrodites; they consist of the same number of petals, but in these the exterior one is larger than the rest, and is divided into two parts; the fruit is roundish, compressed, and divisible into two parts; the seeds are two, oblong, and elegantly ridged at the edges, with round squammæ.

ARTEL, in commerce, a name given to a commercial association, consisting of a certain number of labourers, who voluntarily become responsible, as a body, for the honesty of each individual. The separate earnings of each man are put into the common stock; a monthly allowance is made for his support: and at the end of the year the surplus is equally divided. The number varies in different associations from 50 to 100; and it is considered so beneficial to belong to one of these societies, that 500, and even 1000 rubles are paid for admission. These societies are not bound by any law of the empire, or even written agreement; nor does the merchant restrain them under any legal obligation; yet there has been no instance of their objecting to any just claim, or of protecting an individual, whose conduct had brought a demand on the society. Hence arises the denomination of Artilschisks, who are persons employed by the Russian merchants of St. Petersburg, to collect payment on bills, to receive and pay money, and also to superintend the loading and unloading of the different cargoes. These Russians are mostly natives of Archangel, and the adjacent governments, of the lowest class; they are frequently slaves, generally of the crown; and yet the merchant has no reason to distrust their fidelity, partly from the nature of their association, and partly from the natural reluctance of the Russian to betray the confidence that is reposed in him.

ARTEMISIA, in botany, a genus of plants of the Syngenesia Superflua class and order. Essen. char. receptacle naked or villous; calyx imbricate, with rounded connivent scales; florets of the margin subulate, very entire. This genus is separated into four divisions; A. shrubs or undershrubs; of these there are fourteen species: the most remarkable is A. abrotanum, southern-wood, which seldom grows more than three or four feet high. In some gardens, where the soil is well adapted to its nature, it has been seen much higher: but in mountainous situations, it is low and slender, with the stems lying on the ground. It is bitter and aromatic, with a very strong smell. It is rarely used in medicine but as an ingredient in discutient and antiseptic fomentations. The branches dye wool yellow. B. herbaceous, with the stem quite simple; flowers racemed: of these there are ten species. C. herbaceous; stem more or less branched; flowers panicled; leaves compound: there are about forty species of this division, among which is, 1. A. absinthium, common wormwood, a plant well known in this country. It is found wild in almost every part of Europe, in rocky places by the road-sides, among rubbish, about farm-yards; flowering from July to October. The leaves and flowers are very bitter; the roots are warm and aromatic. A considerable quantity of oil arises from it in distillation, which is used, both externally and internally, to destroy worms. The leaves put into sour beer destroy the acescency. They resist putrefaction, and are therefore a principal ingredient in antiseptic fomentations. An infusion of them is a good stomachic, and, with the addition of a fixed alkali, a powerful diuretic in dropsical cases. The ashes afford a purer alkali than most other vegetables, excepting bean-stalks, broom, and the larger trees. 2. A. vulgaris, mugwort, found wild over the greatest part of Europe, China, Japan. &c. on the borders of fields and ditch-banks, by way-sides, in waste places, and about farm-yards. It is used in some countries as a culinary aromatic. A decoction of it is taken by the common people to cure the ague. The moxa of Japan is prepared from this species. The leaves are collected in June, dried in the shade, and beat in a mortar till they become like tow; this substance is then rubbed between the hands, till the harder fibres and membranes are separated, and there remains nothing but a very fine cotton. The Japanese use it for tinder, and twice in a year, men and women, young and old, rich and poor, are indiscriminately burnt with the moxa, either to prevent disorders, or to cure the rheumatism. D. more or less shrubby; stem branched; leaves undivided; there are five species, of which one is A. cærulescens, tarragon, a capital addition to salads, and much used in France.

ARTERY, in anatomy, a conical tube or canal, which conveys the blood from the heart to all parts of the body. See ANATOMY.

ARTICHOKE. See CYNARA.

ARTICLE, in grammer, a particle, in most languages, that serves to express the several cases and genders of nouns, when the languages have not different terminations to denote the different states and circumstances of nouns. See GRAMMAR.

The Latin has no article; but the Greeks have their *ο*; the eastern languages have their *he emphaticum;* and most of the modern languages have had recourse to articles. The only articles made use of in the English tongue are *a* and *the;* which, prefixed to substantives, determine their general signification to some particular thing. The use of *a* is in a general sense, and may be applied to any particular person or thing, and upon that account is called an indefinite article: but *the*, being a determinate article, is called definite, or demonstrative, as applying the word to one individual. The French have three articles, *le*, *la*, and *les;* the Italians have their *il*, *lo*, and *la;* and the Germans their *der*, *das*, and *dat*.

ARTICLES *of war*, are certain regulations for the better government of the army in the kingdoms of Great Britain and Ireland, and foreign parts dependant upon Great Britain. They may be altered and enlarged, at the pleasure of the king; and in certain cases they extend to civilians—as when by proclamation any place shall be put under martial law, or when people follow a camp or army for the sale of merchandize, or serve in any menial capacity. It is ordained that the articles of war shall be read in the circle of each regiment belonging to the British army every month, or oftener, if the commanding officer think proper. A soldier is not liable to be tried by a military tribunal, unless it can be proved that the articles of war have been duly read to him.

ARTICULATE *sounds*, are such sounds as express the letters, syllables, or words of any alphabet or language; such are formed by the human voice, and by some few birds, as parrots, &c. Other brutes cannot articulate the sounds of their voice.

ARTICULATED, something furnished with, or consisting of joints.

ARTICULATION, in anatomy, denotes the juncture of two bones, intended for motion.

ARTICULATION, in music, applies equally to vocal and to instrumental performances, to words, and to notes; and it includes that distinctness and accuracy of expression, which gives every syllable and sound with truth and perspicuity, and forms the very foundations of pathos and grace.

ARTIFICERS, those who work with the hands, and manufacture any kind of commodity in iron, brass, wood, &c. Artificers are the same with what we otherwise call handicrafts and mechanics; such are smiths, carpenters, taylors, shoemakers, weavers, and the like. The Roman artificers had their peculiar temples, where they assembled, and chose their patron, to defend their causes: they were exempted from all personal services. Taruntinus Paternus reckons thirty-two species of artificers, and Constantine thirty-five, who enjoyed this privilege. The artificers were incorporated into divers colleges or companies, each of which had their tutelar gods, to whom they offered their worship; and several of these, when they quitted their profession, hung up their tools, a votive offering to their gods. Artificers were held a degree below merchants and argentarii, or money-changers, and their employment more sordid. Some deny that, in the earliest ages of the Roman state, artificers were ranked in the number of citizens; others, who assert their citizenship, allow that they were held in contempt, as being unfit for war, and so poor, that they could scarce pay any taxes. For which reason they were not entered among the citizens, in the censor's books; the design of the censors being only to see what number of persons were yearly fit to bear arms, and to pay taxes towards the support of the state. It may be added, that much of the business of artificers was done by slaves and foreigners, who left little for the Romans to mind but their husbandry and war. By means of the arts, the minds of men are engaged in inventions beneficial to the community; and thus prove the grand preservative against the barbarism and brutality which ever attend on an indolent and inactive stupidity. By the English laws, a stranger, being an artificer in London, &c. shall not keep above two stranger servants; but he may have as many English servants and apprentices as he can get. And as to artificers in wool, iron, steel, brass, or other metal, &c. persons contracting with them to go out of the kingdom into any foreign country are to be imprisoned three months, and fined in a sum not exceeding one hundred pounds. And such as going abroad, and not returning on warning given by our ambassadors, &c. shall be disabled from holding lands by descent or devise, from receiving any legacy, &c. and be deemed aliens. Penalty of *500l.* and of imprisonment for twelve months, for the first offence; and for the second, of *1000l.* and of imprisonment for two years; is also inflicted on persons seducing artificers to go abroad.

A stranger-artificer in London shall not keep more than two stranger servants. 2 Hen. VIII. c. 16. Persons contracting with artificers in wool, iron, steel, brass, or other metal, &c. to go to any foreign country, shall be imprisoned three months. 5. Geo. I. c. 27; and if any person shall contract with, or encourage any artificers employed in printing callicoes, cottons, muslins, or linens of any sort, or in making any tools or utensils for such manufactory, to go out of Great Britain to any port beyond the seas, he shall forfeit *500l.* and be committed to the common gaol of the county for 12 months, and untill such forfeiture shall be paid. 22 Geo. III. c. 60 sect. 12.

ARTILLERY, in the most appropriate application of the word, means the cannon, mortars, howitzers, and other large pieces for discharging shot and shells by the expansive force of inflamed gunpowder, as used in the land service. In a more enlarged sense, the word denotes engines of war of all sorts, ancient and modern, by which darts, stones, bullets, &c. were shot forth in battle. See BALLISTA, CATAPULTA, &c.

Artillery, or cannon and mortars, is generally supposed to have been first used in Europe by the Venetians, in the siege of Claudia Jesse, now called Chioggia, in 1366; and in their wars with the Genoese, 1379. But Edward the Third is known to have used cannon at the battle of Cressy, in 1346, and at the siege of Calais, in 1347. And facts that will be mentioned give reason to suppose that it was partially used in this quarter of the world before that period. A treatise of the famous Roger Bacon, written in 1280, is the first European publication which mentions the composition of gun-powder, and proposes its use in war; the invention is, however, most commonly, though unjustly, attributed to Bartholdus Schwartz, a German, in 1320. Bacon only proposed the use of the unconfined flame of gunpowder as a mode of annoying an enemy; but Schwartz is supposed to have discovered its application in projecting heavy bodies, from an accidental explosion of some in a common mortar, in which he had mixed its ingredients together, having blown off an heavy stone cover to a considerable distance; and it is imagined that the mortars now used for throwing shells derived their name from their resemblance to those used by chemists, in one of which the above accident occurring, had first suggested the use that might be made in war of metallic vessels of a somewhat similar form.

The little which was formerly known of Asiatic history, and the undeserved neglect with which it is still treated, made the above account of the origin of cannon satisfactory hitherto. But to consider the invention of cannon as an European invention, at the present period, when we have such authentic documents of their use in China many centuries before they were thought of in this part of the world, would be wilfully to sacrifice truth to the childish vanity, that leads Europeans too often to arrogate an imaginary superiority, in every thing, over the inhabitants of the more early civilized states of the eastern hemisphere.

If the testimony of the Chinese themselves is not sufficient on this point, the fact of their famed great wall being furnished with embrasures, fitted in such a manner for cannon as to leave no doubt of their having been in use at the time of its erection, sufficiently proves it. To which an additional argument may be added, from their very ancient game of chess, in which pieces have been used from remote antiquity, designating engines of war whose power was derived from gunpowder. Mr. Irwin, in his paper on the Chinese Game of Chess, in the Transactions of the Royal Irish Academy, proves that gunpowder was in common use in China 371 years after Confucius, or 161 years before Christ; and Du Halde has long since given documents, to shew that the Chinese wall was in existence 200 years before the commencement of the Christian æra; and consequently, for the reason before stated, the use of cannon must have been of at least equal antiquity. And there is a strong probability that the invention was of a much more remote date; as it is not likely that cannon, immediately after the discovery of gunpowder, would have been brought to sufficient perfection for wall service; or that a very new invention would have been alluded to in the nomination of the pieces used in the game of chess, peculiar to China.

It is so far from an impossibility that the same thing may have been invented by different persons in various parts of the world, that no fact is better proved to have frequently occurred; but to invent an important matter, and to bring it into general use, are distinct affairs, and seldom fall to the lot of the same person.

The discovery made by Bacon was most probably not more attended to in an age of ignorance, than new discoveries are at the present enlightened period, when they make such a slow progress towards universal adoption: and that of Schwartz was evidently of the same nature. It is, therefore, much more probable, that the use of gunpowder in war was derived ultimately from the Chinese, than that it originated in the cell of an obscure monk, such as Schwartz; or of one, though of more notoriety, yet from the prejudices of the times held in abhorrence for an imputation of sorcery, as Bacon was. The mode in which the use of gunpowder in war might have passed from China to Europe is the most probable and simple imaginable. Zingis Khan is known to have conquered the five northern provinces of China about the year 1234. In this conquest, that he must have learned the use of gunpowder, and have practised it afterwards, would have been manifest from reason alone; as at that time it had been in common use in China upwards of 1400 years, from the facts before stated. But we have also the positive testimony of history to attest this point, for in the Chinese annals of the Moguls by Yuen, as translated by Pere Gaubil, it is particularly stated, that the use of cannon and mortars was familiar in the wars and sieges of Zingis against the Chinese, both by them and him, in attack and defence. It is most probable that he used gunpowder in his wars against Mohammed, Sultan of Carisme, whose dominions extended from the Persian gulph to the borders of India and of Turkistan; all which he added to his empire, destroying many flourishing cities, and laying waste a tract of many hundred miles, extending from the Caspian Sea to the Indus, which was richly adorned with the labours and buildings of mankind; and which has not yet in the least recovered from the effect of his ravages. It is well known that he had a body of Chinese engineers in his army, who of course must have been acquainted with the use of gunpowder; and his rapid successes were probably greatly owing to this circumstance. The conquests of Zingis would thus have spread the knowledge of gunpowder over the western part of Asia, where, at the time of the crusades, the Europeans would have frequent opportunities of learning it; and accordingly we find that it was just after this time that it was first used by Europeans in war. At no long period after the return of Edward the First to England, who was so famous for his victories in Palestine, we hear of cannon used by the English against the French. The Venetians, who used them in their wars to so much greater extent, that the invention has been commonly attributed to them, were of all Europeans the most connected with Asia at that period; therefore those who would be most likely to learn the use of gunpowder from the Asiatics: and these are strong testimonies in favour of the introduction of the invention into Europe in the manner stated, especially as we can trace many arts to Asia, which are well known to have been also learned there by Europeans at the time of the Crusades. Another argument in favour of this opinion is, that the first war, in which cannon were much employed in Europe, was one carried on by Asiatics against Europeans, in which they were used exclusively by the Asiatics. It was most remarkable, in this war, at the siege of Constantinople, and in 1453, in which Mahomet the Second used one of the largest cannon ever made, which threw a stone bullet of 600*lbs.* weight. Some knowledge of the use of gunpowder might also have been introduced into Europe by the successes of Zingis, who extended their conquests over a large portion of Russia, the greatest part of Poland, and subdued all Hungary, except three cities, and overran Servia, Bosnia, and Bulgaria; and who must have known its effects in war, when it was used by the armies of their predecessors, as before shewn. In addition to the reasons mentioned for the Asiatic origin of the use of gunpowder, it should be noted that the Germans were one of the last nations in Europe who adopted its use; which renders its having been first invented in that country highly improbable.

ARTILLERY.

It was many years after the introduction of cannon in Europe, before they attained that form and equipment which fitted them for any extensive use. At the siege of Constantinople, before mentioned, which was 107 years after the battle of Cressy, their form was in the highest degree rude and inconvenient; the object of their use then seemed to be, to imitate the effect of the ancient balista in throwing large masses of stone; the large cannon before mentioned, that threw a stone of 600*lbs.* weight, was so unwieldy, that 60 oxen were employed nearly two months in drawing it about 150 miles from Adrianople; and it could be only charged and discharged seven times each day.

We find that, at no very remote period, the chief reliance in war continued to be placed in other implements of battle than those for which gunpowder was necessary. In the reign of Henry the Seventh it appears that cannon were in some degree neglected, as there is said to be no order on record relative to gunpowder or cannon in his reign. In the reign of Elizabeth the effect of the bow and arrow still seems to be preferred in war to that produced by gunpowder, as there were several acts passed by her relative to bows and archery, which shewed them then to be considered as of the utmost importance; and even as late as the reign of Charles the First, two special commissions were granted for enforcing the use of the long bow.

In fact, it is only a few years back since the use of cannon in the field, or artillery properly so called, obtained the predominance it at present holds. The æra of the French revolution may be considered that of its complete adoption; which was not a little aided by the invention of the species called flying artillery, which took place shortly afterwards.

By artillery, is also understood the science which the officers of artillery ought to possess. This science teaches the knowledge of the materials and ingredients that enter into the composition and structure of whatever relates to the artillery: the construction, proportion, &c. of the different warlike machines: the arrangement, movement, and management of cannon, in the field, or in sieges, in such a manner, that each of them, according to the length of its tube, and the diameter of its bore, may be situated in the best place for doing execution: and that the whole train, taken together, may assist and support each other with the greatest advantage.

Cannon are chiefly prepared by casting fused metal into moulds made of a fit form, and afterwards boring out the barrels and touch-holes from the solid mass. They were formerly cast with the barrels hollowed out in part, and were afterwards finished by boring; but the method now in use prepares a greater proportion of perfect pieces out of a given number of casts.

Cannon for field service, or artillery, are usually made of copper, alloyed with about a tenth of tin; the tin adds hardness and solidity to the composition, which (on account of its lightness, its greater durability, and being less liable to burst, and, when that accident occurs, not being apt to fly asunder in small pieces, but rather splitting asunder,) is preferred to cast iron. It is possible to make them even lighter of hammered iron than of the above composition; and a very neatly finished piece of this kind is among the stores at the Warren in Woolwich, sent in some years ago by the maker, as a specimen of what might be done in this way. It was judged that its recoil would be too great, on account of its singular lightness, and therefore this sort was not introduced into actual service; but it would be no great difficulty to prepare carriages for them, so as to admit of having a sufficient load of sand or earth added, when wanted, which might be thrown away when they were to be removed to any distance; and then their great lightness would fit them admirably for service in mountainous countries. Cannon have also been made of staves of hammered iron, bound together by hoops of the same metal, and a large one of this sort may be seen at the Tower; but we have no account as to their use, durability, or safety.

The form preferred for cannon may be defined that of a right cone, obtruncated at the apex, and from which a small cylinder has been subtracted, to form the barrel. The greatest force of the ignited powder being exerted at the breech, a cannon is of course made thickest at that part: its thickness diminishes but little for about a quarter of its length, when it is suddenly reduced in the breadth of its mouldings in that part; it is again reduced abruptly at about half its length, and then continues diminishing very gradually to near the muzzle, where it is again enlarged; it having been found that the shot in departing was apt to exert a greater force against the gun in that place. The two parts of the gun, where the thickness is increased, are called the reinforces. Some guns have been made in foreign countries, which have no reinforces or increase of thickness at the muzzle; a very beautiful one of this description, of brass, of a large size, now lies in St. James's Park, as a trophy of war, brought from Egypt by the victorious troops commanded by General Lord Hutchinson.

The following Table shews the dimensions of heavy, medium, and light brass guns, in thirty second parts of their respective calibres.

			Heavy.	Medium.	Light.
Thickness of metal.	At the breech and commencement of the first reinforce		35	32	22
	End of the first reinforce		26	25	16
	Muzzle astragal		17	16	10
Trunnions.	Diameter		32	30	20
	Length		32	30	24
Cascable.	From the extremity of the base ring to that of the breech mouldings		12	10	9
	From the end of the breech mouldings to the centre of the button		30	24	24
	Breadth of the ovalo, or quarter round		4	3	3
	Diameter	Of the button	32	26	26
		Of the neck	26	22	20
		Of the last fillet	48	44	36

In heavy and medium brass guns, the first and second reinforces are similar frustrums of right cones; and consequently, when produced, their outlines will be parallel to each other, and are distant one-sixteenth part of the calibre. The exterior diameter of the piece is also diminished by that quantity, and its outline is drawn to the muzzle astragal.

In light guns, the length of the piece must be divided into eighteen equal parts, of which

5 parts are taken for the breech and first reinforce;
4 parts for the second reinforce;
9 . . . for the chase;
2½ . . . for the length of the muzzle;
½ part for the diameter of the neck.

The axis of the trunnions are 8 parts from the breech, and half a calibre below the axis of the piece. The position of the trunnions of heavy and medium brass guns is as three-sevenths of the length of the piece, from the extremity of the breech, and half a calibre below the axis of the piece, reckoning to their centres. The diameter of the trunnions are each one calibre, and their length the same, allowing for the projection of the second reinforce ring; their faces are parallel to the axis of the piece. The trunnions of medium and light brass guns have shoulders, which are a tenth of the diameter of the trunnion in breadth, and of sufficient depth to clear the projection of the second reinforce rings.

The vent fields are one-seventeenth of the breech and first reinforce.

The chase girdles are one-fourteenth part of the chase.

The length of the muzzle is equal to the diameter of the second reinforce ring in heavy guns; and in medium guns, one-seventh of the length of the piece. The diameter of the swell of the muzzle is equal to the diameters of the second reinforce rings.

The bottom of the bores of heavy brass guns is a plain surface, meeting the sides in a small arc described with the radius of 1-24th of a calibre: in medium and light guns they are hemispherical, and their vents form an angle of 75 degrees with the axis of the piece; making in light guns one-third of the calibre, and in medium one-fourth of the calibre, from the extremity of the bore.

The vents of heavy guns are a fifth of an inch in diameter.

In medium and light guns there is a portion of metal beneath the neck of the cascable, for receiving the loop of the elevating screw. The lower part of it is the arc of a circle, described with a radius equal to the semidiameter of the neck; of the position of the centre is one-fourth part of the distance from the extremity of the breech moulding to that of the button, and is one-fourteenth of the diameter of the neck below it.

Medium and heavy guns are cast with dolphins, by which they are occasionally suspended, and they consequently should be placed over the centre of gravity of them, or rather so that the breech may preponderate in a small degree.

ARTILLERY.

The following Table shews the calibres of English guns of all sorts.

Pounders	42	32	24	18	12	9	6	4	3	1
Calibre in inches	7,018	6,410	5,824	5,292	4,62	4,328	3,608	3,204	2,913	2,019

Table of the length, weight, and calibres of brass guns, and of the diameter of their shot, and weight of powder for proof and service

Brass guns.	Pounders.	Weight of powder for proof.	Length.	Weight of metal.	Calibre.	Diameter of the shot.	Weight of powder for service.
		l. oz.	ft. in.	ct. qr. lb.	in.	in.	lb. oz.
Heavy . .	42	31 : 8	9 : 6	61 : 0 ; 0	7,018	6,68	14 : 0
	24	21 : 12	9 : 6	53 : 0 : 9	5,824	5,54	8 : 0
	12	12 : 0	9 : 0	29 : 0 : 0	4,623	4,40	4 : 0
	9	9 : 0	9 : 0	26 : 0 : 0	4,200	4,00	3 : 0
	6	6 : 0	8 : 0	19 : 0 : 0	3,668	3,48	2 : 0
	3	3 : 0	7 : 0	11 : 2 : 0	2,913	2,77	1 : 0
	1½	1 : 8	6 : 0	5 : 2 : 0	2,310	2.20	0 : 8
Medium .	24	18 : 0	8 : 0	40 : 1 : 21	5,824	5.45	8 : 0
	12	9 : 0	6 : 6	21 : 0 : 14	4,623	4,40	4 : 0
	6	6 : 0	5 : 0	10 : 1 : 12	3,668	3,48	2 : 0
Light . . .	24	10 : 0	5 : 6	16 : 1 : 12	5,824	5,54	8 : 0
	12	6 : 0	5 : 0	8 : 3 : 18	4,623	4,40	4 : 0
	6	3 : 0	4 : 6	4 : 3 : 14	3,668	3,84	2 : 0
	3	1 : 0	3 : 6	2 : 3 : 4	2.913	2,77	1 : 0

N. B. The above charges for service are established by the Board of Ordnance, but in actual service they are commonly reduced to a third of the weight of the shot.

From the following dimensions of the wheels and axles of an heavy twelve pounder and of a light six pounder, some idea may be formed of the proportion of other parts of their carriages, and also of those of pieces of artillery of the other rates.

	Heavy 12 pounder.	Light 6 pounder.
	ft. in.	ft. in.
Diameter of the wheel	4 : 9,500	4 : 5,
Height of the axletree	0 : 8,250	0 : 6,
Thickness of ditto . .	0 : 6,625	0 : 5,250
Length of ditto	6 : 8,	5 : 3,

The bed of the 12 pounder is 3 feet 3 inches in length.

The most usual mode by which cannon are discharged is, by applying a kindled match to the touch-hole. Locks on a similar principle to musket locks, have been tried in sea service, and have been found to perform very well, but their use is by no means general.

A very great improvement has been made in matches by M. Leroy, who has found that small rods of lime-tree, and some other soft woods, prepared with infusion of nitrate of lead, or nitrate of copper, form matches much superior to the common sort. For the method of making them, see the articles Match and Portfire.

For the construction of iron guns for battering pieces, and garrison and ship guns, mortars, howitzers, and for other particulars relative to artillery in general, see the articles Cannon, Mortars, Howitzers, Gunnery, and Projectiles.

It would appear, at a superficial view, that the adoption of cannon and gunpowder in war had rendered it more bloody and destructive than the method of fighting and the arms formerly in use; but the reverse of this will be found in reality to have taken place. The chief contest in modern warfare is for posts and stations, where artillery can have such command of the adjoining ground, as to give a material superiority; and as the chief combat is carried on from a distance, on a reverse of fortune the defeated have more opportunities of safe retreat. Hence mere extermination of an enemy ceases to be the ultimate design of war: when a post is seized, those under its influence no longer think of contending; the odds, against their success, are so excessive, that it ceases to be any disgrace to yield, and those become prisoners of war, who, in the ancient warfare, must have been devoted to massacre. In the history of remote periods, we often read of 200,000 or more men entering the field of battle, and not more than a dozen or two escaping alive, and in a few instances not even so many. Such sanguinary terminations to engagements never now occur, and it often happens, that in a long campaign not more lives are lost than formerly have perished in a single battle.

The following observations of Dr Smith on the subject shew still more the advantage to mankind in general of the use of cannon, and other modern instruments of war.

"In modern war, the great expense of fire-arms gives an evident advantage to the nation which can best afford that expense; and consequently to an opulent and civilized over a poor and barbarous nation. In ancient times, the opulent and civilized found it difficult to defend themselves against the poor and barbarous nations. In modern times, the poor and barbarous find it difficult to defend themselves against the opulent and civilized. The invention of fire-arms, an invention which at first sight appears to be so pernicious, is certainly favourable both to the permanency and to the extension of civilization.

This circumstance alone reduces the Tartar hordes to comparative insignificance, who in ancient times were so formidable to the civilized world; who more than once have reduced it to primitive ignorance and barbarity, by the indiscriminate destruction of men of science and artists; and whose numbers, which have procured that part of the world they inhabit the name of the *officina gentium*, might be still an object of terror, but for the use of cannon.

Artillery, *flying*, a species of it called so from the celerity with which it is moved from station to station.

Seats are contrived in the carriage and limbers of guns of this sort for the men who work it, and a sufficient number of horses are added to carry the whole at a gallop, when the ground will admit of this pace. Each horse is in general rode by a separate driver, and the men are all trained either to drive or work the gun, as occasion may require.

Flying artillery were first used by the French, shortly after their revolution, and materially assisted them in some of their most signal victories. Their use has now become general in Europe, and may be expected to increase.

ARTIST, in a generul sense, a person skilled in some art; or, according to Mr. Harris's definition, a person possessing an habitual power of becoming the cause of some effect, according to a system of various and well-approved precepts. In this sense, we say, an excellent, a curiuos artist. The pre-eminence is disputed between ancient and modern artists, especially as to what relates to sculpture, painting, and the like. At Vicenza, we are told of a privilege granted to artists, like that of clergy in England; in virtue of this, criminals adjudged to death save their lives, if they can prove themselves the most excellent and consummate workmen in any useful art. This benefit is allowed them in *favorem artis*, for the first offence, except for some particular crimes, of which coining is one. The exception is just, since here the greater the artist, the more dangerous the person. Evelyn's Disc. of Medals, ch. vii. p. 237, &c. Artists are persons who practise those arts which must necessarily be combined with a considerable degree of science, distinguishing them from such as are properly artizans or mechanics. Artists are, particularly, those who study and effect what are termed the polite arts, *i. e.* painting, sculpture, and architecture, to which may be added engraving. It appears that all civilized nations in every age have produced artists, and that with a degree of excellence, generally answerable to their civilization and opulence. In every nation where the arts have flourished, the artists have made but rude essays, and by degrees they have been nurtured up to excellence, except in such instances where they have been transplanted, as from Greece to Rome. It is universally acknowledged respecting statuary and architecture, that ancient Greece has produced the best artists in the world; their works, which have escaped the ravages of time, are the standing monuments of their fame, and are still considered as the models of perfection; there is, however, an uncertainty, whether their painters were equally skilled with their statuaries. With some reason, many judicious persons have supposed they were not; while others contend, that so much excellence produced in one branch must have contemporary artists, who would excel in the other also. While we cannot doubt of the genius of the Grecian artists, and of their ability to produce works of excellence, yet it may not be allowed, that this argument will be found to be so conclusive as it may at first appear, since Chinese and Indian models are found in a more perfect state than either their drawings or paintings. When the Goths overran Italy, the arts were destroyed; and, with Grecian architecture, painting and sculpture lay in one common grave forgotten, until they revived under some artists in the twelfth and thirteenth centuries, who ought not to be named as artists, but for the succeeding effects to which their efforts prepared the way, and in a short time after produced Michael Angelo, Raphael, Correggio, Titian, Algardi, Bernini, &c. painters, sculptors, and architects, to whose works the living artists are almost as much indebted, as these illustrious characters were to the ancient monuments they dug from the ruins of old Rome. See ARTS, *fine.*

ARTOCARPUS, in botany, *bread-fruit tree.* Class, Monoecia Monandria. Male flowers, cal. none; ament cylindrical, all covered with florets; cor. to each two petals, oblong, concave, blunt, villose; stam. filaments single, within each corolla, filiform, the length of the corolla; anther oblong. Female flowers, on the same tree: cal. and corolla none; pist. germs very many; connected into a globe, hexangular style to each, filiform; stigma single, or two, capillary, revolute; per. fruit ovate, globular, compound, muricate; seed for each germ solitary, oblong, covered with a pulpy aril, placed on an ovate receptacle. There are but two species: 1. A. incisa, which is the thickness of a man, and upwards of 40 feet high: the trunk is upright; the wood soft, smooth, and yellowish; the inner bark white, composed of a net of stiffish fibres, the outer bark smooth, but full of chinks, pale ash-colour, with small tubercles thinly scattered over it. Wherever the tree is wounded, it pours out a glutinous milky liquor. The branches form an ample almost globular head; the lower ones, which are the longest, spring from the trunk, 10 or 12 feet above the ground, spreading almost horizontally, scattered, and in a sort of whorl; twigs ascending, bearing flowers and fruit at their ends. In captain Cook's voyage it is observed, that the bread-fruit tree is about the size of a middling oak; its leaves are frequently a foot and a half long, oblong, deeply sinuated, like those of the fig-tree, which they resemble in consistence and colour, and in exuding a milky juice when broken. The fruit is the size and shape of a child's head, and the surface is reticulated not much unlike a truffle; it is covered with a thin skin, and has a core about as big as the handle of a small knife; the eatable part lies between the skin and core; it is as white as snow, and of the consistence of new bread. It must be roasted before it is eaten, being first divided into three or four parts; its taste is insipid, with a slight sweetness, somewhat resembling that of the crumb of wheaten bread mixed with the Jerusalem artichoke. The fruit not being in season all the year, there is a method of supplying this defect, by reducing it to sour paste called makie; and besides this, cocoa nuts, bananas, plantains, and a great variety of other fruits, come in aid of it. This tree not only supplies food, but also clothing, for the bark is stripped off the suckers and formed into a kind of cloth. To procure the fruit for food costs the Otaheiteans no trouble or labour but climbing a tree; which, though it should not indeed shoot up spontaneously, yet, as captain Cook observes, if a man plant ten trees in his life time, he will as completely fulfil his duty to his own and future generations, as the native of our less temperate climate can do by ploughing in the cold winter, and reaping in the summer's heat, as often as these seasons return; even if, after he has procured bread for his present household, he should convert a surplus into money, and lay it up for his children. But where the trees are once introduced in a favourable soil and climate, so far from being obliged to renew them by planting, it seems probable that the inhabitants will rather be under the necessity of preventing their progress; for young trees spring abundantly from the roots of the old ones, which run along near the surface. Accordingly they never plant the bread-fruit tree at Otaheite. The bread-fruit is distinguished into that which is destitute of seeds, and that in which seeds are found. The natives of Otaheite reckon at least eight varieties of trees which produce the former. This most useful tree is distributed very extensively over the East Indian continent and islands, as well as the innumerable islands of the South Seas. In Otaheite, however, and some others, the evident superiority of the seedless variety for food has caused the other to be neglected, and it is consequently almost worn out. We are informed by Captain King, that in the Sandwich islands these trees are planted and flourish with great luxuriance on rising grounds; that they are not indeed in such abundance, but that they produce double the quantity of fruit which they do on the rich plains of Otaheite; that the trees are nearly of the same height, but that the branches begin to strike out from the trunk much lower, and with greater luxuriance; and that the climate of these islands differs very little from that of the West Indian islands, which lie in the same latitude. This reflection probably first suggested the idea of conveying this valuable tree to our islands in the West Indies. For this purpose his Majesty's ship the Bounty sailed, for the South Seas, on the 23d of December, 1787, under the command of lieutenant William Bligh. But a fatal mutiny prevented the accomplishment of this benevolent design. His Majesty, however, not discouraged by the unfortunate event of the voyage, and fully impressed with the importance of securing so useful an article of food as the bread-fruit to our West Indian islands, determined, in the year 1791, to employ another ship for a second expedition on this service; and, in order to secure the success of the voyage as much as possible, it was thought proper, that two vessels should proceed together on this important business. Accordingly, a ship of 400 tons, named the Providence, was engaged for the purpose, and the command of her given to captain Bligh; and a small tender, called the Assistant, commanded by lieutenant Nathaniel Portlock. Sir Joseph Banks, as in the former voyage, directed the equipment of the ship for this particular purpose. Two skilful gardeners were appointed to superintend the trees and plants, from their transplantation at Otaheite, to their delivery at Jamaica; and captain Bligh set sail on the 2d of August, 1791. The number of plants taken on board at Otaheite was 2634, in 1281 pots, tubs, and cases; and of these 1151 were bread-fruit trees. When they arrived at Coupang, 200 plants were dead, but the rest were in good order. Here they procured 92 pots of the fruits of that country. They arrived at St. Helena with 830 fine bread-fruit trees, besides other plants. Here they left some of them, with different fruits of Otaheite and Timor, besides mountain rice and other seeds; and from hence the East Indies may be supplied with them. On their arrival at St. Vincent's, they had 551 cases, containing 678 bread-fruit trees, besides a great number of other fruits and plants, to the number of 1245. Near half this cargo was deposited here, under the care of Mr. Alexander Anderson, the superintendant of his Majesty's botanic garden, for the use of the Windward islands: and the remainder, intended for the Leeward islands, was conveyed to Jamaica, and distributed as the Governor and Council of Jamaica were pleased to direct. The exact number of Bread-fruit trees brought to Jamaica was 352, out of which five only were reserved for the botanic garden at Kew. Though the principal object of this voyage was to procure the bread-fruit tree, yet it was not confined to this only; for the design was, to furnish the West Indian Isles with the most valuable productions of the South Seas and the East Indies. Captain Bligh had the satisfaction, before he quitted Jamaica, of seeing the trees which he had brought, with so much success, in a most flourishing state; insomuch that no doubt remained of their growing well, and speedily producing fruit; an opinion which subsequent reports have confirmed. But though the fruit has been produced in great abundance, it is said not yet to have arrived at that high state of perfection in which it is described to be at Otaheite. Thunberg sent seeds of the East Indian bread-fruit tree from Batavia to the botanic garden at Amsterdam, in 1775. In 1777, he sent some small living plants; and the year following, he brought with him to Europe a great number of plants, both of this and the following species. But the true seedless sort, from the South Seas, was first introduced into the islands of St. Vincent and Jamaica, and into the botanic garden at Kew, by captain Bligh, in

1793. The bread-fruit, when perfectly ripe, is pulpy, sweetish, putrescent, and in this state is thought to be too laxative; but when green it is farinaceous, and esteemed a very wholesome food, either baked under the coals, or roasted over them. The taste is not unlike that of wheaten bread, but with some resemblance to that of Jerusalem artichokes, or potatoes. It was mentioned before, that a sort of cloth was made of the inner bark: to this we may add, that the wood is used in building boats and houses; the male catkins serve for tinder; the leaves for wrapping their food in, and for wiping their hands instead of towels; and the juice for making bird-lime, and as a cement for filling up the cracks of their vessels for holding water. Three trees are supposed to yield sufficient nourishment for one person. 2. A. integrifolia, Indian jacca tree. The East Indian jacca, or jack tree, is about the same size as the foregoing, or perhaps larger. The footstalk is somewhat triangular, smooth, and an inch in length. The fruit weighs 30 pounds and upwards; it has within it frequently from two to three hundred seeds, three or four times as big as almonds; they are ovate-oblong, blunt at one end, sharp at the other, and a little flatted on the sides.

These two species of Artocarpus cannot be distinguished with certainty, either by the form of the leaves, or the situation of the fruit; for the leaves in this are sometimes lobed as on that; and the situation of the fruit varies with the age of this tree, being first borne on the branches, and then on the trunk, and finally on the roots. The jacca tree is a native of Malabar, and the other parts of the East Indies. The fruit is ripe in December, and is then eaten, but is esteemed difficult of digestion; the unripe fruit is also used pickled, or cut into slices and boiled, or fried in palm oil. The nuts are eaten roasted, and the skin which immediately covers them is used instead of the areca nut in chewing betel. The wood of the tree serves for building. No less than 30 varieties of the frut are enumerated in Malabar. It was introduced into the royal botanic garden at Kew, in 1778, by Sir Edward Hughes, Knight of the Bath.

ARTS, *fine*. The Fine Arts may be properly defined those, which, blending elegant ornament with utility, convey intellectual pleasure to the mind, through the medium of the fancy or imagination. They are termed elegant or fine arts, not in opposition to those which are necessary or useful, but to distinguish them from such as are necessary or useful only.

The arts generally distinguished by the appellation fine are, Poetry, Music, Painting, Sculpture, and Engraving, with their several branches. To these we may not improperly add Dancing, and also Architecture; for the latter, although in its origin it was merely appropriated to purposes of utility, has certainly, by its various proportions, modes, and embellishments, become highly ornamental, and impressive to the imagination.

It is perhaps scarcely within the scope of a work of this kind, intended for the promulgation of the best established doctrines on the various branches of human knowledge, rather than as a receptacle for novel and dubious conjecture, to discuss how far the general sense, in which a term is understood, includes its full and entire meaning; otherwise it might not be impossible to shew that many branches of art or science, besides the above mentioned, have an inseparable connection with the fine arts; and that, of consequence, their influence at least, if not their dominion, is much more widely extended than is commonly supposed.

If between poetry and painting there really subsist that close affinity which has been so generally allowed, if they are daughters of the same parent, if their object be the same, the mode by which they accomplish that object alone different, if painting is mute poesy, and the poem a speaking picture, may we not reasonably conclude that there exists some great rule, some primary principle, common to both: and hope, by tracing the conduct of the one art, to throw some additional light on the other? Perhaps the result of an investigation upon the nature and boundaries of the art of poetry would, by analogy, at once bring us to this conclusion, that it is impossible to define the precise limits of the fine arts in general, or what is alone their object.

Although metre or versification be necessary to constitute what is strictly called poesy, still it is by all admitted and felt, that it is the last qualification of a great poet; and hence a noble author, (Lord Lansdown) observes, that "Versification is in poetry what colouring is in painting, a beautiful ornament." "But," he adds, "if the proportions are just, the posture true, the figure bold, and the resemblance according to nature, though the colours happen to be rough, or carelessly laid on, yet the picture shall lose nothing of its esteem. But if skill in versification be the least, what are then the greater qualities which constitute the poet? The question is easily answered: those very qualities, which, in a greater or less degree, are requisite to the formation of an elegant speaker or writer, on almost any subject, whether in prose or verse, with the exception of those of profound or abstruse science. And indeed the different species of prose writers have, from time to time, made such encroachments on what is perhaps more peculiarly the province of poetry; and the poets have, as it were in revenge, adopted so many of those subjects which belong more properly to prose; that the chief difference now remaining between the two parties seems to be, that the latter express their thoughts through the medium of metre or rhyme, and the former without that ornament. Who will deny the title of poet to the authors of Telemachus and the Death of Abel? And who will deny, that some of those treatises which have employed the ingenuity of poets, under the title of didactic poems, would better have attained the object of instruction and conviction to the reader, had they been written in the energetic prose of a Bacon, a Swift, or a Johnson?

That a similitude between poetry and painting, as before mentioned, really subsists, there can be little doubt; nor would it be difficult to point out instances of productions in each of these arts, as well as of music, so resembling in character, as to seem, as it were, different emanations from one spirit, and alike calculated to excite kindred sensations in the breast of the hearer or spectator. But, however close the comparison might have been at the period when that comparison was first made, when each art was, in fact, applied to effect similar purposes, though through different means, it is certain that, since the objects of their pursuit have become more varied and extended, the propriety of the comparison between them has proportionably diminished.

But if, instead of contenting ourselves with retracing the old parallel of poetry with painting, we were to take a wider range, and consider the arts of design as a mode of conveying ideas, or as analogous to language or writing in general, such an enquiry might lead us to a just appreciation of their importance, by exhibiting a comprehensive view of the extent of their powers, and of the modes of applying those powers, as means for the attainment of any desired end.

The arts of design we may then consider as a language, by which, though all things cannot be expressed, many at least may, in a stronger and clearer manner than can be effected by any other. And it is scarcely necessary to add, that all those arts or sciences, to the comprehension or practice of which lineation or modelling is requisite, are more or less dependent on design.

The arts of design, or those dependent on design, may be divided into three great classes: arts, simply useful or nenessary; arts, whose object it is to unite elegance with utility; and arts, whose aim is more decidedly to elevate the human mind, by an appropriate choice of the most grand and beautiful objects.

Design, so far as it is requisite for the common purposes of life, as building dwelling-houses, planning convenient furniture, forming canals, raising aqueducts, &c. is a useful, or indeed a necessary art. Without design, by which the explanatory figures are furnished, the first principles of geometry and the mathematics, the foundation of so large a portion of human knowledge, would be unintelligible. Without design, we should be ignorant of the situations and bearings of different countries; without the assistance of maps and charts, the pilot would be ignorant what course to steer; nay, the compass itself may be termed the offspring of design. By her means, without the constant recurrence to dissection, the physician and surgeon are instructed in the various situations and appearances of the bones, veins, nerves, muscles, and every other part of the human frame; and, by her assistance, the visible symptoms of disorders can be accurately described, when words would have been inadequate to the task.

If we consider design as applicable to those arts, sciences, or manufactures, whose object it is to combine utility and instruction with ornament and amusement, we shall find her province not less extended. The chair, the sofa, the table, and the lamp, no longer confined to the purposes of mere necessity, present themselves, adorned with all the graces of Grecian art, at once the instruments of our comfort, and the embellishment of our apartments. By means of design, we are transported to foreign climes; we behold their buildings, processions, dresses, &c.: with her assistance, the traveller is enabled to teach us their customs and manners, and instruct us in the process of their manufactures; the deepest recesses of the earth are laid before us, and the whole animal creation, with the wonders of the deep, are not withheld from our view.

The arts of design, considered more strictly as elegant arts, have a no less extensive and noble scope: our edifices rise with majestic beauty; the column, the obelisk, and the statue, perpetuate the remembrance of departed worth; whilst the picture excites us, by its representations, to emulate the heroic deeds of former times, or transports us to the alluring regions of fancy.

We have perhaps said sufficient to shew the difficulty, nay, the impossibility, of defining the precise limits of the fine arts in general. Of each in particular it is not our intention here to speak, nor shall we undertake a laborious and unprofitable inquiry respecting the pretensions of any one of them to priority of existence or superiority of rank. Each has its allotted office, and they journey on, hand in hand, reciprocally decorating and assisting each other, the coeval, and perhaps the coequal, offspring of the same parent. See POETRY, PAINTING, DRAWING, SCULPTURE, ENGRAVING, ARCHITECTURE, MUSIC, and DANCING.

ARUM, in botany, a genus of plants of the Monoecia Hexandria class and order. Spathe one-leafed; convolute at the base; spadix cylindrical, androgynous, naked above, bearing the stamina in the middle, and the germs at the base. There are three divisions, and upwards of thirty species. A. without stems; leaves compound. B. without stems; leaves simple. C. caulescent. Of the species we notice, 1. A. dracontium, dragon, which has a large, tuberous, fleshy root, which, in the spring puts up a straight stalk about 3 feet high, spotted like the belly of a snake; at the top it spreads out into leaves, which are cut into several narrow segments almost to the bottom; at the top of the stalk the flower is produced, which has so strong a scent of carrion, that few persons can endure it. It grows naturally in most of the southern parts of Europe, and is preserved in gardens, to supply the markets with the roots which are used in medicine. 2. A. maculatum, cuckow-pint, wake robin: the common appellation is *lords and ladies*, and in Worcestershire it is called *bloody men's fingers*. It is a native of most parts of Europe, except the very northern ones, in shady places, and on the banks of ditches: flowering in May. The berries ripen at the close of summer. The root and leaves of arum, when recent, are extremely acrid, and affect the tongue with a pungency as if it were pricked with needles. This sensation may be alleviated by milk, butter, or oil. When dried, they may be used for food in case of necessity. The root, dried and powdered, is used by the French as a wash for the skin, and is sold under the name of cypress powder. 3. A. seguinum, dumb-cane, arum, grows naturally in the sugar islands, and other warm parts of America, chiefly in the low grounds; the plants abound in acrid juice, so that if a leaf or a part of the stalk be broken, and applied to the tip of the tongue, it causes a very painful sensation, and such an irritation as to prevent a person from speaking; hence its name in Jamaica, where it is said they sometimes rub the mouths of their negroes with it by way of punishment. The stalk is used to bring sugar to a good grain, when the juice is too viscid, and cannot be brought to granulate with lime.

ARUNA, in botany, a genus of the Diandria Digynia class and order. Gen. char. calyx four-parted, the divisions reflected; berry one-celled, one or two-seeded, there is but a single species, a tree with wide spreading branches, found in Guiana.

ARUNDELIAN *marbles*, called also the Parian Chronicle, are supposed to be ancient stones, on which is inscribed a chronicle of the city of Athens, engraven in capital letters in the island of Paros, one of the Cyclades, 264 years before the Christian æra. They are frequently denominated Oxford marbles, and derive their name either from the Earl of Arundel, who procured them out of the east, or from his grandson, who presented them to the University of Oxford: in the former case they are called Arundelian, and in the latter Oxford marbles. These and other ancient relics were purchased in Asia Minor, Greece, and the islands of the Archipelago, by Mr. William Petty, who was employed, in the year 1624, by the Earl of Arundel, for the purpose. They arrived in England about the year 1627, and were placed in the gardens belonging to Arundel house in London. Having excited a considerable share of curiosity among the learned, Mr. Seldon undertook to explain the Greek inscriptions, which he did in a small quarto volume, under the title of "Marmora Arundeliana," containing nearly forty inscriptions, with annotations. During the civil wars, these marbles were defaced and much injured, and some of them entirely lost, or made use of for the ordinary purposes of building. In 1667, what were left of these curious remains were presented to the University of Oxford, when a new edition of Selden's work was published, with additional notes, by the celebrated Dr. Prideaux. Mr. Mattaire, in 1731, gave the public a more comprehensive view of these marbles, and in 1763, Dr. Chandler published a new and improved copy of them, in which he corrected the errors of the former editors, and supplied the deficiencics in some of the inscriptions, particularly those of the Parian Chronicle, by many ingenious conjectures. These marbles, in their perfect state, contained a chronological detail of the principal events of Greece, from the commencement of the reign of Cecrops, in the year before Christ, 1582, to the close of the archonate of Diognetus, in the year 264 A. C. The chronicle of the last 90 years is lost, and the others are much defaced and corroded, of course the sense can only be discovered by very learned and industrious antiquaries, or supplied by conjectures. Almost every event in this table, between the destruction of Troy and the annual magistracy of Athens, is dated 26 years earlier than in the canons of Eusebius, and those of other approved chronologers. These marbles have been applied to the elucidation of many parts of ancient history; but their inconsistency with other authentic records has depreciated their value and use. Their authenticity has been doubted, and the question ably discussed by Mr. Robertson and Mr. Hewlett, the former being inclined to give up, and the latter to vindicate, the authenticity of the Parian chronicle.

ARUNDO, *common reed*, in botany, a genus of the Triandria Digynia class of plants, the calyx of which is a glume, formed of two oblong, acuminated valves, not aristated, one longer than the other. The corolla is formed of two valves, of the length of the cup, of an oblong, acuminated figure, with a lanuginous matter at the base, of the length of the flower; the corolla adheres to the seed, and serves as a pericarpium; the seed is single, oblong, pointed, and downy at the base. There are 14 species, of which we notice, 1. A. bambos, bamboo-cane, which has a woody, hollow, round, straight culm, forty feet high and upwards, simple and shining; it grows naturally almost every where within the tropical regions. Over a great part of Asia it is very common. It has been long cultivated here. Some of the plants have been seen twenty feet high; a strong shoot from the root has been known to grow twenty feet in five or six weeks. See BAMBOO. 2. A. phragmites, the common reed, which flowers from July to September, and is common by the sides of rivers, in ditches, and large standing waters. In autumn, when the leaves begin to fall, and the stems are changed brown, it is cut for making screens in kitchen gardens, and for many other uses, as thatching, for which it is more durable than straw; for ceilings, and to lay across the frame of wood-work, as the foundation for plaister floors. The panicles are used by the country people in Sweden to dye wool green.

ARUSPICES, or HARUSPICES, an order of priesthood, among the Romans, that pretended to foretel future events by inspecting the entrails of victims killed in sacrifice; they were also consulted on occasions of portents and prodigies. It appears that women were admitted into this order.

AS, in antiquity, a particular weight, consisting of twelve ounces; being the same with libra, or the Roman pound.

As was also the name of a Roman coin, which was of different matter and weight, according to the different ages of the commonwealth.

It is also used to signify an integer, divisible into twelve parts, from which last acceptation it signified a whole inheritance. The as had several divisions, the principal of which were the uncia, or ounce, being the twelfth part of the as; sextans, the sixth part of the as; quadrans, the fourth part; triens, the third part; and semis, half the as, or six ounces. Bes was two thirds of the as, or eight ounces; and dodrans, three-fourths of the as.

ASAFŒTIDA, in chemistry, a gum resin obtained from ferula asafœtida, a perennial plant, which is a native of Persia. When the plant is about four years old, its roots are dug up and cleaned, and from their extremity, when cut, a milky juice exudes, which soon hardens, and constitutes asafœtida. It comes into this and other countries in Europe in small grains, of different colours, hard and brittle. Its taste is acrid and bitter, its smell is strongly alliaceous and fetid. Alcohol dissolves three-fourths of this substance, and water takes up about one-fourth, if applied before the spirit. It yields an oil, when distilled with water and alcohol. The specific gravity is 1.32.

ASARUM, or ASARABACCA, in botany, a genus of plants without any flower-leaves, and belonging to the Dodecandria Monogynia class of Linnæus. Its fruit is a coriaceous capsule, divided into six cells, and containing a great many oval seeds. There are three species. The common asarabacca is a native of many parts of Europe, in woods and shady places, flowering in April and May. With us it is found only in Lancashire. The root finely powdered excites vomiting; coarsely powdered it purges. The powder of the leaves is the basis of most cephalic snuffs, which occasion a considerable discharge of mucus from the nostrils without much sneezing.

ASBESTUS, in mineralogy, a species of the Talc family, well known to the ancients, who made a kind of cloth from one of the varieties, which was famous for its incombustibility. It is found in primitive mountains, especially in serpentine, which it traverses in veins. It is divided by Werner into four sub-species, *viz.* 1. The elastic asbest, or rock-cork, which is of a yellowish grey, of various intensity: occurs sometimes massive, sometimes in plates, and with impressions. At first sight it appears to be fine grained, uneven. Opaque very seldom; translucent on the edges; somewhat elastically flexible; cracks when handled. Specific gravity .09 to .068. 2. The amianthus, of a greenish white, passing into a greenish grey, sometimes blood red. Massive, also in plates and small veins, and in capillary crystals. Internally its lustre is glistening, passing to shining: fracture parallelly fibrous, and sometimes a little curved. It is found in primitive rocks in Sweden, Bohemia, Silecia, Italy, Hungary, Siberia, France, Spain, and Scotland. From its flexibility, and its resisting the effects of fire, it is said to have been by the ancients woven into a kind of cloth, in which they wrapped the bodies of persons of distinction before they were placed on the funeral pile, that their ashes might be collected free from admixture. It was also used for incombustible wicks; but is now considered only as an object of curiosity. To these may be added, 3. The common asbestus; and 4. The rock-wood: which differ too little from the former sub-species to demand particular notice. According to Cheneviz, the amianthus consists of

Silica . .	59.0
Magnesia .	25.0
Lime . .	9.25
Alumina .	3.0
Iron . . .	2.25
	98.5
Loss . .	1.5
	100.—

ASCARINA, in botany, a genus of the Dioecia Monandria class and order. Ament filiform; no corolla. Male, anthera worm-shaped, four-grooved: female, stigmata three-lobed: drupe. One species, in the Society Isles.

ASCARIS, in natural history, a genus of worms of the order Intestina. Body round, elastic, and tapering towards each extremity; head with three vesicles; tail obtuse or subulate; intestines spiral: milk white and pellucid. There are about 80 species, separated into divisions, *viz.* A. infesting mammalia; B. found in birds; C. infesting reptiles; D. infesting fish; and E. infesting worms. A. vermicularis: head subulate: skin at the sides of the body very finely crenate, or wrinkled; inhabits the intestines of children and thin people, principally in the rectum. They are generally found in considerable numbers, and occasion many troublesome symptoms, creeping sometimes up into the stomach. They are viviparous, and about half an inch long. The female has a small punctiform aperture a little below the head, through which the young are protruded. A. lumbricus, inhabits the intestines of thin persons, generally about the ileum, but sometimes ascends into the stomach, and creeps out of the mouth and nostrils. They are frequently very numerous and vivacious, from twelve to fifteen inches long: body transparent, of a light yellow, and with a faint line down the side. They are oviparous, and distinguished from the earth worm, in wanting the fleshy ring below the head, and in having three vesicles.

ASCENSION, in astronomy, the rising of the sun or a star, or any part of the equinoctial with it, above the horizon: is either right or oblique.

Right ascension is that degree of the equator, reckoned from the beginning of Aries, which rises with the sun, or a star, in a right sphere. It is found by the following proportion. As the radius to the cosine of the sun or star's greatest declination, so is the tangent of the distance from Aries to Libra to the tangent of right ascension.

Oblique ascension is that degree and minute of the equinoctial, counting from the beginning of Aries, which rises with the centre of the sun, or a star, or which comes to the horison at the same time as the sun or star in an oblique sphere. In order to find the oblique ascension, we must first find the ascentional difference.

The arch of right ascension coincides

with the right ascension itself, and is the same in all parts of the globe. The arch of oblique ascension coincides with the oblique ascension, and changes according to the latitude of places.

The sun's right ascension in time is useful to the practical astronomer in regular observatories, who adjusts his clock by sideral time. It serves also for converting apparent into sideral time; as *e. g.* that of an eclipse of Jupiter's satellites, in order to know at what time it may be expected to happen by his clocks. For this purpose the sun's right ascension at the preceding noon, together with the increase of right ascension from noon, must be added to the apparent time of the phenomenon set down in the ephemeris. The sun's right ascension in time serves also for computing the apparent time of a known star's passing the meridian: thus, subtract the sun's right ascension in time at noon from the star's right ascension in time, the remainder is the apparent time of the star's passing the meridian nearly; from which the proportional part of the daily increase of the sun's right ascension from this apparent time from noon being subtracted, leaves the correct time of the star's passing the meridian. The sun's right ascension in time is also useful for computing the time of the moon and planets passing the meridian. The practical method of finding the right ascension of a body from that of a fixed star, by a clock adjusted to sideral time, is this: let the clock begin its motion from $0^h\ 0'\ 0''$ at the instant the first point of Aries is on the meridian; then, when any star comes to the meridian, the clock would shew the apparent right ascension of the star, the right ascension being estimated in time at the rate of 15° an hour, provided the clock was subject to no error; because it would then shew at any time how far the first point of Aries was from the meridian. But as the clock is liable to err, we must be able at any time to ascertain its error, or the difference between the right ascension shewn by the clock, and the right ascension of that point of the equator which is at that time on the meridian. To do this we must, when a star, whose right ascension is known, passes the meridian, compare its apparent right ascension with the right ascension shewn by the clock, and the difference will shew the error of the clock. *E. g.* Let the apparent right ascension of Aldebaran be $4^h\ 23'\ 50''$, at the time when its transit over the meridian is observed by the clock; and suppose the time shewn by the clock to be $4^h\ 23'\ 52''$, then there is an error of $2''$ in the clock, as it gives the right ascension of the star $2''$ more than it ought. If the clock be compared with several stars, and the mean error taken, we shall have more accurately the error at the mean time of all the observations. These observations being repeated every day, will give the rate of the clock's going, or shew how much it gains or loses. The error of the clock and the rate of its going being thus ascertained, if the time of the transit of any body be observed, and the error of the clock at the time be applied, we shall have the right ascension of the body. This is the method by which the right ascension of the sun, moon, and planets, are regularly found in observatories. To find the right ascensions mechanically by the globe, see Globes, *the use of*. The arch of right ascension is that portion of the equator intercepted between the beginning of Aries and the point of the equator which is in the meridian: or it is the number of degrees contained in it. This coincides with the right ascension itself. The right ascension is the same in all parts of the globe. We sometimes also say, the right ascension of a point of the ecliptic, or any other point of the heavens. The right ascension of the mid heaven is often used by astronomers, particularly in calculating eclipses by the nonagesimal degree; and it denotes the right ascension of that point of the equator which is in the meridian, and is equal to the sum of the sun's right ascension and the horary angle or true time reduced to degrees, or to the sum of the mean longitude of the sun and mean time.

ASCENSIONAL *difference*, the difference between the right and oblique ascension in any point of the heavens; or it is the space of time that the sun rises or sets before or after six o'clock.

The ascensional difference may be found by this proportion, *viz.* As the radius is to the latitude of the place, so is the tangent of the sun's declination to the sine of the ascensional difference; by subtracting of which from the right ascension, when the sun is in the northern signs, and adding it, when the sun is in the southern ones, you will find the oblique ascension.

ASCENT *of fluids*, is particularly understood of their rising above their own level, between the surfaces of nearly contiguous bodies, or in slender capillary glass tubes, or in vessels filled with sand, ashes, or the like porous substances. This effect happens as well in vacuo as in the open air, and in crooked as well as straight tubes. Some liquors, as spirit of wine and oil of turpentine, ascend with greater celerity than others; and some rise after a different manner from others. Mercury does not ascend at all, but rather subsides. Upon the same principle, two smooth polished plates of glass, metal, stone, or other matter, being so disposed as to be almost contiguous, have the effect of several parallel capillary tubes; and the fluid rises in them accordingly: the like may be said of a vessel filled with sand, &c. the divers little interstices of which form as it were a kind of capillary tubes: so that the same principle accounts for the appearance in them all. And to the same may probably be ascribed the ascent of the sap in vegetables. Thus Sir I. Newton says, if a large pipe of glass be filled with sifted ashes, well pressed together, and one end dipped into stagnant water, the fluid will ascend slowly in the ashes, so as in the space of a week or fortnight to reach the height of 30 or 40 inches above the stagnant water. This ascent is wholly owing to the action of those particles of the ashes which are upon the surface of the elevated water; those within the water attracting as much downwards as upwards: it follows that the action of such particles is very strong; though, being less dense and close than those of the glass, their action is not equal to that of glass, which keeps quicksilver suspended to the height of 60 or 70 inches, and therefore acts with a force which would keep water suspended to the height of about 60 feet. By the same principle a sponge sucks in water; and the glands in the bodies of animals, according to their several natures and dispositions, imbibe various juices from the blood. If a drop of oil, water, or other fluid, be laid on a glass plane, perpendicular to the horizon, so as to stand without breaking or running off, and another plane inclined to the former, so as to meet at top, be brought to touch the drop, then will the drop break, and ascend towards the touching end of the planes; and it will ascend the faster in proportion as it is higher, because the distance between the planes is constantly decreasing. After the same manner the drop may be brought to any part of the planes, either upward or downward, or sideways, by altering the angle of inclination. Lastly, if the same perpendicular planes be so placed as that two of their sides meet, and form a small angle, the other two only being kept apart by the interposition of some thin body, and thus immerged in a fluid tinged with some colour, the fluid will ascend between the planes, and this the highest where the planes are nearest, so as to form a curve line which is found to be a just hyperbola, one of the asymptotes whereof is the line of the fluid, the other being a line drawn along the touching sides. The physical cause in all these phenomena is the same power of attraction.

ASCIDIA, in natural history, a genus of worms, of the order Mollusca. Body fixed, roundish, with two apertures, generally placed near the upper end, one beneath the other. There are more than 40 species found in the sea, adhering by their base to rocks, shells, and other submarine substances. They are more or less gelatinous, and have the power of squirting out the water which they take in. Some of them are esculent, most of them sessile, though a few are furnished with a long stalk, or tubular stem. They alternately contract and dilate themselves, and are often found in great numbers adhering to the bottoms of ships.

ASCII, among geographers, an appellation given to those inhabitants of the earth, who, at certain seasons of the year, have no shadow: such are all the inhabitants of the torrid zone, when the sun is vertical to them.

ASCIUM, in botany, a genus of the Polyandria Monogynia class and order. Character: calyx five-leaved; petals five; berry four-celled, with two seeds in each. One species in Guiana, a tree 80 feet high.

ASCLEPIAS, *swallow-wort*, in botany, a genus of the Pentandria Digynia class of plants, the calyx of which is a permanent perianthium, divided into five acute and small segments; the corolla consists of a single petal, divided into five deep segments at the mouth; and its fruit consists of two follicles or vaginæ, containing a great number of imbricated seeds, winged with down. There are about 40 species. The swallow-worts are either shrubs or tall upright perennial herbaceous plants, milky and poisonous, or at least acrid. The flowers are borne on solitary peduncles, several together in umbels, and surrounded with a many-leaved involucre. They are very singular in their structure. Flies, in searching for the honey in the nectary, are frequently caught by the legs, and are not able to extricate themselves. A. syriaca is a native of North America, where the tender shoots are eaten as we eat asparagus. The flowers are so odoriferous as to make it very agreeable to travel in the woods, especially in the evening. They make a sugar of them in Canada, gathering them in the morning, when they are covered with dew. Poor people collect the cotton from the pods, and fill their beds with it.

ASCOBOLUS, a genus of the Cryptogamia Fungi. Fungus semi-spherical, containing oblong vesicles, somewhat immersed in its disk, which eject the seeds with an elastic force.

ASCOPHORA, a genus of the Cryptogamia Fungi. Fungus erect, on a setaceous stalk; head globular-oblong; inflated, opake, elastic, bearing the seeds externally. There are seven species, and two divisions. A. clustered on a common receptacle. B. detached.

ASCYRUM, in botany, a genus of plants with a rosaceous flower, and an oblong capsular fruit, formed of two valves, and containing a number of small, roundish seeds. It belongs to the Polyadelphia Polyandria class of Linnæus, and is so nearly allied to the Hypericum, that Tournefort makes it the same genus; from which, however, it is distinguished by having only four petals, whereas the hypericum has five.

ASH, in botany. See Fraxinus.

ASILUS, in natural history, a genus of insects of the order Diptera. Essential character: mouth with a straight, horny, bivalve snout. The most common European species of asilus is the A. caraboniformis, a moderately large insect, nearly equalling a hornet in length, but of a much more slender and sharpened form: the head and thorax are of a ferruginous colour: the eyes black: the upper half of the abdomen velvet black; the lower half bright orange colour; the whole having a bright silky or downy surface: the wings are a dull yellow brown, and marked on their inner edge by several dusky triangular dashes or spots. Though of a somewhat formidable aspect, this insect is incapable of piercing with any degree of severity. It preys on the smaller kind of insects, and proceeds from a smooth, white, subterraneous larva, of lengthened shape, and destitute of legs: the pupa resembles that of the tipula. There are seventy species.

ASPALATHUS, *aspalath*, in botany, a genus of the Diadelphia Decandria class of plants, the calyx of which consists of a single-leafed perianthium, divided into five segments: the corolla is papilionaceous; the fruit is a roundish, turgid, unilocular, bivalve pod; the seed is single, and frequently kidney-shaped. According to Martyn there are 37 species; but Gmelin has enumerated nearly double that number. The plants of this genus, with few exceptions, are natives of the Cape of Good Hope. They are shrubby, or at least under-shrubs. The leaves are simple: the flowers mostly yellow. They may be propagated here by seeds brought from the Cape.

ASPARAGIN, a name given to a lately discovered juice of asparagus, which was discovered by expression and evaporation. Various crystals gradually make their appearance, and among others crystals of asparagin, easily separated from the rest on account of their colour and figure. The crystals are white and transparent, and have the figure of rhomboidal prisms: it is hard and brittle, and its taste is cool and slightly nauseous, so as to occasion a secretion of saliva. It dissolves in hot water, but not in alcohol. The aqueous solution does not affect vegetable blues Neither infusion of galls, acetate of lead, oxalate of ammonia, muriate of barytes, nor the hydro-sulphurat, occasion any change in it. When triturated with potash, no ammonia is disengaged. When heated it smells, and emits penetrating vapours, affecting the eyes and nose like the smoke of wood. Nitric acid dissolves it with the evolution of nitrous gas. These properties distinguish it from all other vegetable substances.

ASPARAGUS, in botany. Class, Hexandria Monogynia. Gen. char. cal. none; cor. petals, six, cohering by the claws, oblong, erected into a tube, three alternately interior, permanent; stam. filaments six, filiform, inserted into the petals, erect, shorter than the corolla; anthers roundish; pist. germ. ſturbinate, three-cornered; style very short; stigma a prominent point; perberry globular, umbilicated with a point, three-celled; seeds two, round, angular on the inside, smooth.

Asparagus, in gardening, comprehends one of the most valuable esculent vegetables of the kitchen-garden; it has erect, herbaceous stalks, three or four feet in height, and very fine bristly leaves: it is a perennial fibrous-rooted vegetable, the roots being of many years duration, but the tops or stalks annual. The plants being raised from seed, after having acquired a period of three or four years growth, produce proper sized asparagus, of which the same roots furnish an annual supply for many years, continuing to rise in perfection for six or eight weeks in the summer season; the shoots afterwards run up to stalks and flowers, and perfect seeds in autumn. But, besides the crop raised in the summer season, it may also be obtained in perfection during the winter, and early in the spring, by the aid of hot-beds.

Asparagus is always three years at least, from the time of sowing the seed, before the plants obtain strength enough to produce shoots of due size for the table; that is, one year in the seed-bed, and two after being transplanted, though it is sometimes three or four years after planting before they produce good full-sized shoots. But the same bed or plantation will continue producing good asparagus ten or twelve years, and even endure fifteen or twenty years. However, at that age the shoots are generally small, and the whole annual produce inconsiderable. A new plantation should, therefore, be made every eight, ten, or twelve years, as may be judged necessary. When new plantations of asparagus are required to be raised in the quickest manner for use, it should be done by purchasing ready-raised year-old plants of the nursery-men or kitchen-gardeners, as in this way a year may be gained.

ASPARAGUS, in chemistry. This plant has been lately analyzed: the filtered juice had the appearance of whey, and reddened the infusion of litmus. When heated, it deposited flakes, which were considered as albumen. When left a long time to evaporate in the open air, a quantity of asparagin, and of saccharine matter, having the appearance of manna, separated in crystals. See ASPARAGIN.

ASPARAGUS *stone*, in mineralogy, found only at Caprera in Murcia, a province of Spain, which has been considered by some French chemists as a crysolite. Colour, asparagus-green, sometimes passing to a greenish-white, or pistachio-green, sometimes between orange and yellowish brown; always crystallized in equiangular six-sided prisms; frangible, brittle. Specific gravity 3.09. It dissolves in the nitrous acid with effervescence, but does not exhibit a phosphoric light when laid on coals. Its constituent parts are,

Lime . . .	53.32
Phosphoric acid	45.72
	99.04

ASPERUGO, in botany, a genus of the Pentandria Monogynia class of plants, the flower of which consists of one rotated petal, divided into several segments at the limb; and its calyx, which is divided like the flower petal, contains the seeds, which are four in number, and of a roundish compressed figure. There are two species.

ASPERULA, *woodruffe*, in botany, a genus of the Tetrandria Monogynia class of plants, the flower of which consists of one petal, divided into four segments at the limb; and its fruit is composed of two roundish, dry berries, adhering together, in each of which is a single seed of the same roundish shape.

There are eleven species. The common sweet-scented woodruffe is a native of many parts of Europe, in woods and shady places. The scent is pleasant, and, when dried, diffuses an odour like that of vernal grass. It gives a grateful flavour to wine; and when kept among clothes, it not only imparts an agreeable perfume to them, but is said to preserve them from insects.

ASPHALTUM, in chemistry, one of the proper bitumens, found in great abundance in different countries, especially in the island of Trinidad, on the shores of the Red Sea, and in Albania, where it is found in vast strata. It is supposed that it was first liquid, and that it acquired solidity by exposure to the air. Its colour is black, with a shade of brown, red, or grey. Its specific gravity varies. That of Albania, as ascertained by Klaproth, was 1.20; but it was somewhat contaminated with earth. Kirwan, in purer specimens, found the specific gravity to vary from 1.07 to 1.16. Klaproth has lately published an analysis of the asphaltum of Albania. He found it insoluble, both in acids and alkalies, as also in water and alcohol; but soluble in oils, petroleum, and sulphuric ether. Five parts of rectified petroleum dissolved one part of asphaltum without the assistance of heat, and formed a blackish brown solution, which, by gentle evaporation, left the asphaltum in the state of a black brown shining varnish. The solution in ether was of a pale brown red colour; and when evaporated, the asphaltum remained in the state of a semifluid substance, of a reddish colour, still insoluble in alcohol. A hundred grains of this asphaltum being distilled in a retort, by a heat gradually raised to redness, yielded the following products.

	Grains.
Heavy inflammable air	16
A light brown fluid oil	32
Water slightly tainted with ammonia	6
Charcoal	30
Ashes	16
	100

These ashes consisted chiefly of silica and alumina, with some iron, lime, and manganese. The asphaltum found in Albania is supposed to have constituted the chief ingredient of the Greek fire. The Egyptians are said to have employed this bitumen in embalming. It was called mumia mineralis. The ancients inform us that it was used instead of mortar in building the walls of Babylon. The Arabians still use a solution of it in oil to besmear their horse harness, to preserve it from insects. Buildings are said to be constructed with this pitch; and Peter de Vol mentions, that he examined very old buildings, the stones of which were cemented by means of mineral pitch; and which were still firm and good. Asphaltum is seldom absolutely pure; for when alcohol is digested on it, the colour of the liquid becomes yellow, and, by gentle evaporation, a portion of petrolium is separated. Mineral tar seems to be nothing else than asphaltum containing a still greater proportion of petroleum. When alcohol is digested on it, a considerable quantity of that oil is taken up; but there remains a black fluid substance like melted pitch, not acted upon by alcohol, and which therefore appears to possess the properties of asphaltum, with the exception of not being solid. By exposure to the air, it is said to assume gradually the state of asphaltum.

ASPHODEL, in botany, a genus of the Hexandria Monogynia class of plants, the flower of which is liliaceous, consisting of a single petal, divided into six segments; and its fruit is a globose-trilocular capsule, containing a number of triangular seeds, gibbous on one side.

According to Martyn, there are three species. The yellow asphodel is a native of Sicily. Of the white, there are immense tracts of land in Apulia covered with it, for the purpose of feeding sheep. The onion-leaved asphodel is an annual, that grows naturally in France, Spain, and the island of Crete. The yellow and white are pretty ornaments for a flower garden, and cultivated with very little trouble. They may be própagated with seeds, which should be sown soon after they are ripe.

ASPHYXIA, in medicine, a term which signifies want of pulsation, and is used to denote apparent death. Such suspensions of the vital actions are referred by Cullen to apoplexy and syncope. See MEDICINE.

ASPLENIUM, *milt-waste, or spleen-wort*, in botany, a genus of Cryptogamia Filices plants, the fructification of which is arranged in clusters, and disposed in form of straight lines, under the disk of the leaf.

There are, according to Willdenow, 99 species. Martyn observes, that whoever is desirous of cultivating these ferns must have walls, rocks, or heaps of stones, to set the hardy species in; or pots may be filled with loamy undunged earth, or sand, gravel, and lime rubbish, for that purpose, placing them in the shade. The American species, according to Muhlenberg, are eight in number.

ASS. See EQUUS.

ASSAULT, in law, a violent injury offered to a man's person, being of a higher nature than battery; for it may be committed by offering a blow, or a terrifying speech. In case a person threatens to beat another, or lies in wait to do it, if the other is hindered in his business, and receives loss, it will be an assault, for which an action may be brought, and damages recovered. Not only striking, but thrusting, pushing, casting stones, or throwing drink in the face of any person, are deemed assaults.

In all which cases a man may plead in his justification, the defence of his person or goods, father, mother, wife, master, &c.

ASSAYING, is a term particularly applied to the separation of gold or silver from other metals. In its more extended meaning it is used for the determination of the quantity of any metal whatsoever, in composition with any other metal or mineral.

The assaying of gold or silver is divided into two operations; by the first they are separated from the imperfect metals, or those easily oxyded; by the second they are parted from the metals which resist oxydation by simple exposure to air, and which are therefore called the perfect metals; this second process generally consists in parting gold and silver from each other, as the third perfect metal, platina, is but seldom found united to them.

The basis of the method of separating gold or silver from the imperfect metals is founded on the facility with which the latter imbibes oxygen; and the process is calculated to accelerate this operation as much as possible; hence the oxide of lead, or litharge, is generally considered as the most powerful purifier of the perfect metals, from the ease with which it parts with its oxygen to the imperfect metals united with them; but of late, oxide of manganese has been found superior to it, in several instances, for this purpose. In the chemical analyses of metals, the oxide of lead is generally preferred for the above purpose; but in the assays performed by authority, metallic lead is always used, probably from the ease it is supposed to afford in determining the weight of the different ingredients by calculation. The lead in the process first becomes oxyded. Then yields some of its oxygen to the other imperfect metals, and afterwards becomes vitrified, in conjunction with the other oxides so formed, and carries them off along with it, leaving the perfect metals pure. The above operation is called cupellation, and is performed on a flat round cake of bone ash, compressed within an iron ring, that is named a cupel; this is placed in a vessel called a muffle, which resembles an oven in miniature, that is fixed in a furnace capable of giving a heat sufficient for the fusion of gold, so that its mouth may come in contact with the door, at the side to which it is luted, to separate it from the peal; there are small slits formed in the sides of the muffle, to afford a passage for the air.

When the muffle and empty cupels are heated red hot, a little powdered chalk is put on the floor of the muffle, to prevent the cupels from adhering to it after the operation. Cupels should be always of size proportionate to the lead to be used, as they cannot absorb a weight of litharge, at the utmost, more than their own.

The assay of silver is performed in this country on a piece of metal not exceeding thirty-six grains, if the alloy appears considerable; which piece is laminated, and weighed with extreme accuracy in a very sensible balance. It is then wrapped up in the requisite quantity of lead, rolled out into a sheet, which is revived from litharge, that it may be free from the silver which lead in general contains naturally.

The silver and lead are put on the cupel when it and the muffle are red hot. The metal immediately melts, and begins to send off dense fumes, and a minute stream of red fused matter is seen perpetually flowing from the top of the globule, down its sides, to the surface of the cupel, where it sinks; the fume consists of lead in vapour, and the red stream of vitrified lead which carries down with it the copper, or other alloy of silver, into the cupel. As the cupellation advances, the melted button becomes rounder, its surface becomes streaky, with large bright points of the fused oxide, which move with increased rapidity; the last portions of the litharge on the surface quickly disappear, shewing the melted metal with bright iridescent colours, which directly after becomes opaque, and then suddenly appears brilliant, clean, and white, as if a curtain had been withdrawn from it; at which time the assayers say it lightens. The silver is now left pure, and the cupel is allowed to cool gradually till the globule of silver is fixed, when it is taken out while still hot, and, when cold, weighed with as much accuracy as at first. The difference between the weight of the globule, and that of the silver first put in, shews the quantity of alloy. If the globule is cooled too quickly, the outward surface contracts so suddenly as to force out the fluid metal at the centre in arborescent shoots, by which some portion is lost, and the assay spoiled.

In the assays for the mint in this country, two assays are always made of the same mass of metal, and no sensible difference between the weights of the buttons is allowed to pass in scales that turn with the $\frac{1}{1300}$ part of a grain, troy. If they differ, the assay is repeated.

The process is considered as well performed, when the button adheres but slightly to the cupel; when its shape is very considerably globular above and below, and not flattened at the margin; when it is quite clear and brilliant, and not folded or spotted with any remaining litharge; and, especially when the surface is disposed in minute scales, the effect of a hasty crystallization, which gives it a play of light very different from that of a perfectly even surface of a white metal. The scales are of a pentagonal form, slightly depressed at the centre. When any alloy remains in the silver, the surface appears, under the microscope, smooth, as if varnished, and scarcely at all scaly in texture.

In the common assays of plate, either gold or silver, copper is the alloy usually met with; if the fine metal be nearly pure, the cupel round the bottom is only stained yellow by the litharge; if copper is contained, it leaves a brown stain. The other metals, except bismuth, scarcely penetrate the substance of the cupel, but remain on the edges of its cavity, in the form of coloured scoriæ; of which iron is black, tin grey, and zinc a dull yellow.

The management of the fire is a point of great consequence in cupellation. When silver is kept in fusion in a very high heat, a portion of it is volatalized, as Mr. Tillet found that a button of pure silver, kept in a very high heat, lost a twentieth part of its weight; which loss would cause a great error in assaying. On the other hand, when the fire is too slack, the litharge is not absorbed by the cupel, but lies on the surface as a red scoria. The heat is known to be too great, when the cupel can scarcely be distinguished from the muffle, and the ascending fume can scarcely be seen for the dazzling heat. Towards the end of the operation the fire should be gradually increased, for in proportion as the lead is abstracted from the alloy, it becomes less easy of fusion; and at last a heat fully equal to the melting of pure silver is required.

As the cupellation requires a free access of air, as well as an high degree of heat, the stopper of the muffle is always removed as soon as the metal is put into the hot cupel, to allow a current of air to pass through the muffle: but to prevent this from cooling the muffle too fast, several round pieces of charcoal are heaped up, in front of the muffle, on an iron plate placed there to hold them, which burn with sufficient force to heat the air as it passes to the cupels. The furnace should be made so that the heat of the fuel within may be readily increased or diminished, but at the same time so that it can be kept up with steadiness.

The time taken up in making one assay of silver, is generally from 15 to 25 minutes. The proportioning of the lead to the supposed alloy in the silver to be assayed is of great importance; if too little is employed, some of the alloy will remain in the mass; but if too much is used, some of the silver will be wasted; for Mr. Tillet has found, that when the proper quantity of lead is used it carries down a portion of the silver into the cupel, which he has ascertained by accurate experiments to amount to $\frac{1}{128}$ of the lead in the cupel; whereas the natural admixture of silver in lead is only $\frac{1}{1152}$. But when an excess of lead is employed for cupellation, this loss of silver is somewhat greater, though it does not increase in the ratio of the excess of lead; for ten parts of lead to a given alloy will not carry down twice as much silver as five parts, though the difference of loss will be very sensible. When the litharge carried into the cupel is reduced to reguline lead, on being cupelled a second time, it will yield a button of silver, fully equal to the loss of this metal in the first assay. In all these reductions the silver appears equally distributed through the lead, for Mr. Tillet found that separate globules of the lead, spurted out by accident upon an empty cupel in the muffle, each left a minute atom of silver lying upon the spot where the globules had scorified.

Bismuth will serve the same purpose as lead in cupellation; but, besides being dearer, it is found to carry down with it into the cupel somewhat more of the silver than the same quantity of lead does.

To estimate the quantity of alloy in silver, the ancient assayers used touch-needles, or small slips of silver, alloyed with known proportions of copper, in a regularly increasing series, from the least to the greatest proportion ever used. The silver to be assayed was compared with these, and its alloy estimated by that of the needle, to which it shewed the closest resemblance. But an experienced assayer is at the present time able to judge of the alloy with sufficient exactness, by the ease or difficulty with which the silver is cut, by the colour and grain of a fresh cut surface, the malleability, the change of surface when made red hot, and the general appearance.

The assay of gold is more complicated than that of silver. The baser metals may be separated from it by cupellation in the same manner as from silver, except copper, which has so strong an affinity for gold, that it can scarcely be overcome by this method, unless silver is first combined with the mass; and this makes the second operation necessary, mentioned before, namely, the parting of the gold from the silver.

The process of parting is performed by the aquafortis of commerce, which dissolves the silver, and leaves the gold untouched. But in this operation it is found, that when the gold exceeds a certain proportion in the mixture, it so much protects the silver from the acid, as more or less to prevent its action. Therefore, when the gold is in excess, it becomes necessary to add so much silver as to give this metal the predominance. The proportion of silver generally used is three parts to one of the gold, from whence the process obtained the name of quartation. Several good assayers think two parts of silver are sufficient. More than three parts also may be used, but then it will protract the process needlessly.

Though when copper also as well as silver is present, the parting may be proceeded to, as this metal is likewise soluble in aquafortis; yet it is found to have some advantages to cupel the mixture first with lead; and likewise even when no copper is combined with the gold.

The cupellation of gold is thus conducted; the portion of the alloy of silver being estimated by touch-needles, as much silver is added as will make the entire quantity of this metal about thrice the weight of pure gold.

The proportion of lead to the alloy of copper, or other base metal, is nearly the same as for silver; which will be shewn particularly in the annexed table. The heat necessary in the process is greater than for silver, and may be used with freedom, as none of the gold is lost by volatilization. The lighting of the fused globule of gold takes place as in silver. The button is cooled, taken out and weighed, then hammered flat and annealed, and afterwards laminated between steel rollers to a thin plate about the substance of a wafer, again heated to redness, and then coiled up into a spiral roll. The button of gold, when it lightens, still retains a minute portion of lead; this may be got rid of by its being kept a little time in fusion in a clean vessel. The lead entirely disappears after parting.

The spiral roll is called a cornet, and when prepared is put into a glass matrass, shaped like a pear, in order to part the silver from it, and about thrice its weight of pure nitric acid poured on it moderately diluted, (so as to be about 1.25 specific gravity.) The glass is set on a sand bath, or over charcoal, to boil. When warm, the acid dissolves the silver; as long as it continues to act, the cornet is studded with minute bubbles: when these discontinue, or are united in one large one, it is a sign that the acid has ceased to operate. About twenty minutes are required for this process.

The cornet is now corroded throughout, having lost its silver; it retains the same form, but is very slender and brittle. It is of importance to the accuracy of the assay that it should not be broken. The hot acid solution of silver is then poured off with great care, and fresh acid, rather stronger, is added, to clear away all remains of the silver, and boiled as before, but only for five or six minutes. It is then decanted, and added to the first solution, and the parting glass is filled with hot distilled water, to wash off all remains of the solution. A small crucible is to be inverted over the glass while it is full of water, the latter is then nimbly turned, and the cornet falls gently into the crucible through the water; which being poured off, the crucible is dried and heated to redness under a muffle, when the cornet shrinks extremely in every direction, becomes firm, and, when cooled, regains its metallic lustre, and is soft and flexible. It is then most accurately weighed, and the process is finished.

The final weight of the gold cornet indicates the absolute quantity of this metal in the assayed sample. The difference between the weight of the button after cupellation (deducting the silver added) and the first sample, is the weight of the copper, or other base metal in the gold; and the difference between the gold cornet, together with the silver added, and the button after cupellation, is the quantity of silver with which the gold was alloyed.

The silver is usually recovered from the solution left after parting, by immersing in it plates of bright copper, which dissolve and precipitate the silver in its metallic form.

Touch-needles for gold are formed in the same manner as for silver, but more of them are required, as the various combinations of three metals are to be examined by them in this case. Four sets of them are usually employed; one in which pure silver is used for the alloy, another in which the alloy is two parts silver and one of copper, a third with two parts copper and one of silver, and a fourth of copper only. In trials with these needles nitric acid is of singular service; a drop of it is let fall on the streak of metal on the touch-stone; in eight or ten seconds it is washed off and the effect observed. If the streak preserves its golden brilliance unaltered, the metal is judged to be of a certain degree of fineness. If it looks red, dull, and coppery, it is less fine; but if the streak is almost entirely effaced, it contains very little gold.

A peculiar set of weights are used for assaying.

The quantity of metal taken for an assay is always very small; in this country generally from 18 to 36 grains troy for silver, and from 6 to 12 grains for gold. This is the integer, and whatever be its real weight, it is denominated the assay pound. This imaginary pound is then subdivided into aliquot parts, but differing according to the metal. The silver assay pound is subdivided into 12 imaginary ounces, each ounce into 20 pennyweights; and, for assaying, these again into halves.

The following is the table of the proportions of lead required to different alloys of copper. In the three first columns is shown the absolute increase of the quantity of lead in alloys of decreasing fineness. In the three last columns will be seen the gradual diminution of the protecting power of fine metal against scorification, in proportion to the increase of alloy, shewn by the decreasing quantity of lead required for the same weigh of copper, under different mixtures.

Silver.		Copper.		Lead.		Ratio of Inc.		Copper.		Silver.		Lead.
23	with	1	requires	96	=	4 × 24	and hence	1	with	23	requires	96
22		2		144	=	6 × 24		1		11		72
20		4		192	=	8 × 24		1		5		48
18		6		240	=	10 × 24		1		3		40
16		8		288	=	12 × 24		1		2		36
14		10		336	=	14 × 24		1		1⅖		33
12		12		384	=	16 × 24		1		1		32
10		14		432	=	18 × 24		1		$\frac{5}{7}$		30 ×
8		16		480	=	20 × 24		1		½		30
6		18		528	=	22 × 24		1		⅓		29 ×
4		20		576	=	24 × 24		1		⅕		28 ×
2		22		624	=	26 × 24		1		$\frac{1}{11}$		28 ×

It should be remarked, however, that many assayers, of good authority, use proportions of lead to alloy, considerably different from the above table; and that the whole numbers here given may be considered as rather high in proportion to the quantity of lead.

The proportions of lead for gold assaying are nearly the same as for silver.

Assays of alloys with platina are conducted nearly in the same manner as for the mixtures of silver and gold. Silver is seldom alloyed with it; but gold is more frequently; and is known by the much greater heat it requires in the fusion; by the edges of the button appearing thicker and rounder than in common assays of gold; by its colour being duller, and tending to yellow; and its being entirely crystallised on its surface.

The action of nitrous acids on the alloys of platina is very remarkable. By itself, platina is as insoluble in this acid as gold, and a mixture of these two metals equally resists its action; but when silver enters into the mixture, in the proportion of 2½, or three times the weight of the gold and platina, and when the platina is not above a tenth of the gold, the platina is totally soluble in nitrous acid, together with the silver, and the gold alone remains untouched.

When the gold mixed with platina is to be freed from it in the above manner, it must be laminated very thin; a weak acid is first added, and boiled for some time. If the platina is above two per cent. of the gold, the acid assumes a straw colour, which deepens in proportion to the platina, and at the same time the cornets assume a brownish green. A stronger acid is then added, and boiled three times successively, to detach the last portions of platina, which are separated with difficulty. By laminating very fine, using the acid liberally, and long boiling, all the platina may be separated in one operation, when it does not exceed a tenth of the gold: and above that proportion, the colour of the gold is so much debased, and the appearances on the cupel so striking, that fraud can hardly escape an experienced eye. Parting might be used even when the platina was more than a tenth of the gold, but then more silver must be added, which would render the cornet so very thin, after the action of the acid, that it could hardly be annealed without breaking.

When alloys of silver alone with platina are treated with nitrous acid, the silver dissolves as usual, but the liquor soon becomes muddy, with a very fine bulky black precipitate, which continues increasing till all the silver is dissolved, and which is found to be entirely platina when collected. A part of the platina, however, remains in the solution; for, on adding muriatic acid to the liquor separated from the black precipitate, white luna cornea falls down, after which carbonate of potash will throw down a green coagulum, which is oxide of platina. The above effects of nitrous acid will therefore detect an alloy of silver and platina.

ASSETS, are goods or property in the hands of a person, with which he is enabled to discharge an obligation imposed upon him by another; they may be either real or personal. Where a person holds lands in fee-simple, and dies seized thereof, those lands, when they come to the heir, are called assets. So far as obligations are left on the part of the deceased to be fulfilled, they are called assets real When such assets fall into the management of executors, they are called assets intermaines. When the property left consists of goods, money, or personal property, they are called assets personal.

ASSIENTO, a Spanish word, signifying a farm, in commerce, is used for a bargain between the king of Spain and other powers, for importing negroes into the Spanish dominions in America, and particularly in Buenos Ayres. The first assiento was made by the French Guinea Company: and, by the treaty of Utrecht, transferred to the English, who were to furnish four thousand eight hundred negroes annually.

ASSIGN, in common law, a person to whom a thing is assigned or made over.

ASSIGNEE, in law, a person appointed by another to do an act, transact some business, or enjoy a particular commodity. Assignees may be by deed, or by law; by deed, where the lessee of a farm assigns the same to another; by law, where the law makes an assignee, without any appointment of the person entitled; as an executor is assignee in law to the testator, and an administrator to an intestate. But when there is an assignee by deed, the assignee in law is not allowed.

ASSIGNING, in a general sense, is the setting over a right to another; and, in a special sense, is used to set forth and point at, as to assign an error, to assign false judgment, to assign waste; in which cases, it must be shewn wherein the error is committed, where and how the judgment is unjust, and where the waste is committed.

ASSIGNMENT, is a transfer, or making over to another, of the right one has in any estate; but it is usually applied to an estate for life or years. And it differs in a lease only in this; that by a lease one grants an interest less than his own, reserving to himself a reversion; in assignment he parts with the whole property, and the assignee stands, to all intents and purposes, in the place of the assignor. 2 Black. 326.

Assignment, in a military sense, signifies a public document, by which colonels of regiments become entitled to certain allowances for the clothing of their several corps.

ASSIMILATION, in animal economy, is that process, by which the different ingredients of the blood are made parts of the various organs of the body. Over the nature of assimilation, says Dr. Thomson, the thickest darkness hangs; there is no key to explain it, nothing to lead us to the knowledge of the instruments employed. Facts, however, put the existence of the process beyond the reach of doubt. The healing of every fractured bone, and of every wound of the body, is a proof of its existence, and an instance of its action. Every organ employed in assimilation has a peculiar office, and it always performs this office whenever it has materials to act upon, even when the performance of it is contrary to the interest of the animal. Thus the stomach always converts the food into chyme, even when the food is of such a nature that the process of digestion is retarded, rather than promoted, by the change. If warm milk be taken into the stomach, it is decomposed by that organ, and converted into chyme, yet the milk was more nearly assimilated to the animal before the action of the stomach than after it. The same thing occurs when we eat animal food. If a substance be introduced into an organ employed in assimilation, that has already undergone the change which that organ is fitted to produce, it is not acted upon by that organ, but passes on unaltered to the next assimilating organ. Thus it is the office of the intestines to convert chyme into chyle; and whenever chyme is introduced into the intestines, they perform their office, and produce the usual change; but if chyle itself be introduced, it is absorbed by the lacteals without alteration. Again, the business of the blood-vessels, as assimilating organs, is to convert chyle into blood; chyle therefore cannot be introduced into the arteries without undergoing that change; but blood may be introduced from another animal without any injury, and consequently without undergoing any change. Though the different assimilating organs have the power of changing certain substances into others, and of throwing out the useless ingredients, yet this power is not absolute, even when the substances on which they act are proper for undergoing the change which the organs produce. The stomach converts food into chyme, and the intestines change chyme into chyle; and the substances that have not been converted into chyle are thrown out of the body. If there should be present in the stomach and intestines any substance, which, though incapable of undergoing these changes, at least by the action of the stomach and intestines, yet has a strong affinity either for the whole chyme and chyle, or for some particular part of it, and no affinity for the substances which are thrown out; that substance passes with the chyle, and in many cases continues to remain chemically combined with the substance to which it is united in the stomach, even after the substance has been completely assimilated, and made a part of the body of the animal. Thus there is an affinity between the colouring matter of madder and phosphate of lime; and when madder is taken into the stomach, it combines with the phosphate of lime of the food, passes with it through the lacteals and blood-vessels, and is deposited with it in the bones. In the same way musk, indigo, &c. when taken into the stomach, make their way into many of the secretions. These facts prove that assimilation is a chemical process; that all the changes are produced according to the laws of chemistry; and Dr. Thompson adds, that we can derange the regularity of the process, by introducing substances whose mutual affinities are too strong for the organs to overcome. See PHYSIOLOGY.

ASSISE, in old law-books, is defined to be an assembly of knights and other substantial men, with the justice, in a certain place, and at a certain time; but the word, in its present acceptation, is used for the court, place, or time, when and where the writs and processes, whether civil or criminal, are decided by judges and jury. In this signification, assise is either general, when judges make their respective circuits, with commission to take all assise; or special, where a commission is granted to particular persons for taking an assise upon one or two disseisins only. By magna charta, justices shall be sent through every county, once a year, who, with the knights of the several shires, shall take assise of novel disseisin; and as to the general assise, all the counties of England are divided into six circuits, and two judges are assigned by the king's commission to every circuit, who now hold the assises twice a year, in every county, except Middlesex, where the courts of record sit, and the counties palatine. These judges have five several commissions. 1. Of oyer and terminer, by which they are empowered to try treasons, felonies, &c. 2. Of gaol-delivery, which empowers them to try every prisoner in gaol, for whatever offence he be committed. 3. Of assise, which gives them power to do right upon writs brought by persons wrongfully thrust out of their lands and possessions. 4. Of nisi-prius, by which civil causes, come to issue in the courts above, are tried in the vacation by a jury of twelve men, in the county where the cause of action arises. 5. A commission of the peace in every county of the circuit; and all justices of peace of the county, and sheriffs, are to attend upon the judges, otherwise they shall be fined.

ASSOCIATION *of ideas*, is where two or more ideas constantly and immediately follow one another, so that the one shall almost infallibly produce the other, whether there be any natural relation between them or not.

When our ideas have a natural correspondence and connection one with another, it is the office and excellency of our reason to trace these, and hold them together in that union and correspondence, which is founded in their peculiar beings. But when there is no affinity between them, nor any cause to be assigned for their accompanying each other, but what is owing to mere accident or custom, this unnatural association becomes a great imperfection, and is, generally speaking, a main cause of error, or wrong deductions in reasoning.

To this wrong association of ideas, made in our minds by custom, Mr. Locke attributes most of the sympathies and antipathies observable in men, which work as strongly, and produce as regular effects, as if they were natural, though they at first had no other original than the accidental connection of two ideas, which, either by the strength of the first impression, or future indulgence, are so united, that they ever after keep company together in that man's mind, as if they were but one idea.

The ideas of goblins and spirits have really no more to do with darkness than light; yet, let but these be inculcated often in the mind of a child, and there raised together, possibly he shall never be able to separate them again as long as he lives, but darkness shall ever afterwards bring with it these frightful ideas.

So, if a man receive an injury from another, and think on the man and that action over and over, by ruminating on them strongly, he so cements these two ideas together, that he makes them almost one; he never thinks on the man, but the place and displeasure he suffered come into his mind with it, so that he scarce distinguishes them, but has as much aversion for the one as the other. Thus hatreds are often begotten from slight and almost innocent occasions, and quarrels are propagated and continued in the world.

Nor is its influence on the intellectual habits less powerful, though less observed. Let the ideas of being and matter be strongly joined, either by education or much thought, whilst these are still combined in the mind, what notions, what reasonings, will there be about separate spirits? Let custom, from the very childhood, have joined figure and shape to the idea of God; and what absurdities will that mind be liable to about the Deity? Some such wrong and unnatural associations of ideas will be found to establish the irreconcileable opposition between different sects of philosophy and religion; for we cannot suppose that every one of their followers will impose wilfully on himself, and knowingly refuse truth offered by plain reason. Some independent ideas, of no alliance to one another, are, by custom, education, and the constant din of their party, so coupled in their minds, that they always appear there together, and they can no more separate them in their thoughts, than if they were but one idea; and they operate as if they were so.

ASSONIA, in botany, a genus of the Monadelphia Dodecandria plants, and of the natural order of Columniferæ Malvaceæ of Jussieu. The essential character is, calyx double, outer one-leaved or three-leaved, inner one-leaved; corol five-petalled, without any tube, affixed to the pitcher of stamens; filament connected in form of a pitcher, with petal-shaped straps between them; style one or five; capsule five-celled; seeds not winged. There are eleven species.

ASSUMPSIT, a voluntary or verbal promise, whereby a person assumes, or takes upon him to perform or pay any thing to another. When any person becomes legally indebted to another for goods sold, the law implies a promise that he will pay his debt; and if he do not pay it, the writ *indebitatus assumpsit* lies against him; and will lie for goods sold and delivered to a stranger, or third person, at the request of the defendant; but the price agreed on must be proved, otherwise that action does not lie.

ASSURANCE, or INSURANCE, an engagement by which a person is indemnified from the loss he would sustain by the happening of a particular event; as by the capture or wreck of a ship at sea, or the destruction of goods by fire. Projects have at different times been formed for assuring against frauds and robbery, against losses by servants, the death of cattle, and almost every event, by which unforeseen loss may arise; but such schemes have always failed, and the business of assurance is now generally confined to the risks of the sea, assurance against fire, and the assurance of lives.

This mode of securing merchants against the dangers of navigation is said to have originated in the time of the Emperor Claudius, but during the subsequent decline of commerce it probably fell into disuse. The sea laws of Oleron, as far back as the year 1194, treat of it, and it was soon after practised in Great Britain. The statute of 43 of Queen Elizabeth, cap. 12, states, that it has been time out of mind a usage among merchants, both of this country and of foreign nations, to make assurances on their goods, merchandize, and ships going to foreign parts; for the better regulation of which, with respect to disputes which arose on policies of assurance, commissioners were appointed, who were to meet weekly at the Office of Insurance on the west side of the Royal Exchange, to determine all causes concerning policies of assurance in a summary way, but reserving a right of appeal to the Court of Chancery. This shows that such assurances were in common practice, and had become of considerable importance.

Assurance against the dangers of the sea appears to have been in use in England somewhat earlier than in many commercial cities on the continent, as the policies of assurance of Antwerp, and also of other places in the Low Countries, contained a clause, that they should be construed in all things according to the custom of Lombard street in London. In the year 1627, Charles I. granted a monopoly for 31 years of the right of making all assurances on ships or goods in the City of London.

In 1712, several attempts were made to establish offices for assurance on marriages, births, &c. which all failed. In 1719, the Royal Exchange Assurance and London Assurance companies were formed, and in the following year obtained charters of incorporation, by which they were distinguished from a variety of schemes for every species of assurance then projected, most of which were of very short duration. The two companies just mentioned are the only corporate bodies authorized to make sea assurances, the principal part of this business, in London, being transacted by four or five hundred individual assurers, or under-writers, who assemble daily for this purpose at Lloyd's coffee-house, formerly in Lombard street, but now kept over the Royal Exchange. The premiums which they require are regulated by the length or danger of the voyage, the condition of the vessel, the time of the year, and the country being at peace or war; of course they vary considerably at different periods. Thus, in time of peace, an assurance may be made from London to the East Indies, on the Company's regular ships, at 6 or 7 guineas *per cent*. out and home, which in time of war is advanced to 12 guineas *per cent*.

At Hamburgh there are about thirty companies for making sea assurances, two or three in Bremen, some in Lubeck and Trieste, and one even in Berlin and Breslaw; there is also a chartered marine assurance company at Stockholm, and one at Copenhagen; their capitals, however, are not very considerable, and they never venture large sums on one risk. There are private underwriters at Stockholm, Gottenburg, and Copenhagen, who assure moderate risks. At New York, Philadelphia, and many other principal towns in the American states, assurance companies have been established; and in the East Indies, there are no less than five assurance offices at Calcutta, four or five at Madras, and one at Bombay; but their business is not very extensive, being principally confined to the assurance of the coasting trade in India, and the trade from India to China.

Assurance against loss or damage from fire is a practice, the utility of which has become so generally evident, that it has of late years increased considerably. Dr. A. Smith, in 1775, supposed, that, taking the whole kingdom at an average, 19 houses in 20, or perhaps 99 in 100, were not insured from fire. But the case is now very different, as there is scarcely any considerable town in England which has not in it either an office of its own, or agents from the London offices, for effecting assurances.

All kinds of property liable to be destroyed by fire, as houses and buildings of every description, household furniture, apparel, merchandize, utensils, and stock in trade, farming stock, and ships, in harbour or while building, may be assured at a fixed rate *per cent;* but all kinds of writings, accounts, notes, money, and gunpowder, are generally excepted.

The offices distinguish the different risks of assurance against fire in the following manner:

Common assurances are assurances on all manner of buildings, having the walls of brick or stone, and covered with slate, tile, or metal, wherein no hazardous trades are carried on, nor any hazardous goods deposited: and on goods and merchandizes, not hazardous, in such buildings. The premium on such assurances is 2*s*. *per cent. per annum*.

Hazardous assurances are, assurances on timber or plaster buildings, covered with slate, tile, or metal, wherein no hazardous trades are carried on, nor any hazardous goods deposited; and on goods or merchandizes, not hazardous, in such timber or plaster buildings; and also on hazardous trades, such as cabinet and coach makers, carpenters, coopers, bread and biscuit bakers, ship and tallow chandlers, soap-makers, inn-holders, sailmakers, maltsters, and stable-keepers, carried on in brick or stone buildings, covered with slate, tile, or metal; and on hazardous goods, such as hemp, flax, rosin, pitch, tar, and turpentine, deposited in such buildings; the stock in trade of apothecaries, also on ships, and all manner of water-craft, in harbour, in dock, or while building, and on thatched buildings, which have not a chimney, and which do not adjoin to any building having a chimney. The charge for this class of assurance is 3*s*. *per cent. per annum*.

Doubly hazardous assurances are, assurances on any of the aforesaid hazardous trades carried on, or hazardous goods deposited in timber or plaster buildings, covered with slate, tile, or metal; on glass, china, and earthen ware; also on thatched buildings, or goods therein, (except as in the preceding class,) and on saltpetre, with the buildings containing the same. Such assurances are usually charged 5*s*. *per cent. per annum*.

Assurances on jewels, plate, medals, watches, prints not in trade, pictures, drawings, and statuary work: also assurances to cotton-spinners, and all other manufacturers of raw cotton; to distillers, flambeau and varnish makers; to oil, spermaceti, wax, or sugar refiners; to boat-builders, cork cutters, japanners, colourmen, rope-makers, sea-biscuit bakers, and tallow-melters; or on chymists' laboratories; mills, or any other assurances more than ordinarily hazardous, by reason of the trade, nature of the goods, narrowness of the place, by the use of kilns or stoves in the process of any manufactory, or other dangerous circumstances, are made by special agreement, at a premium proportionate to the risk.

Assurances on building and goods are deemed distinct and separate adventures, so that the premium on goods is not advanced by reason of any assurance on the building wherein the goods are kept, nor the premium on the building by reason of any assurance on the goods; and any number of dwelling-houses and outhouses, together with the goods therein, may be assured in one policy, provided the sum to be assured on each is particularly mentioned.

In 1782, a duty of 1*s.* 6*d.* was imposed on every 100*l.* assured from loss by fire, which was increased in 1797 to 2*s.* *per cent.* and in 1804 to 2*s.* 6*d.* *per cent.*, the annual duty now payable. From the produce of this duty, an estimate has been formed of the total amount of property assured from fire in Great Britain, which appears to have been nearly as follows:

In 1785 . . .	*L.* 125,000,000
1789	142,000,000
1793	167,000,000
1797	184,000,000
1801	223,000,000
1806	260,000,000

In the year last mentioned there were eleven offices for assurance against fire in London, and 21 in other parts of Great Britain.

Assurance *on lives*, secures a sum of money to be received on the extinction of any life, in consideration of an annual premium paid to the assurer during the continuance of the life. Such assurances are made for a given term of years, or during the whole continuance of the life, or the joint continuance of two lives; and as they are of great utility to persons having life incomes or life estates, and as collateral securities, in many cases, for money borrowed, this species of assurance, as it has become more generally understood, has likewise greatly increased. In 1790 there were only three societies in London which made assurances on lives; in 1807 there were ten offices for transacting such business. These offices all require nearly the same annual premiums, of which the following are a specimen.

Age.	1 Year.			7 Years.			Whole Life.		
	L.	*s.*	*d.*	*L.*	*s.*	*d.*	*L.*	*s.*	*d.*
10	0	17	9	1	1	5	1	17	11
15	0	17	11	1	2	11	1	18	7
20	1	7	3	1	9	5	2	3	7
25	1	10	7	1	12	1	2	8	1
30	1	13	3	1	14	11	2	13	5
35	1	16	4	1	18	10	2	19	8
40	2	0	8	2	4	1	3	7	11
45	2	6	8	2	10	10	3	17	11
50	2	15	1	3	0	8	4	10	10
55	3	5	0	3	12	0	5	6	4
60	3	18	1	4	7	1	6	7	4
65	4	15	2	5	10	10	7	16	9
67	5	5	6	6	5	2	8	12	1

These rates are computed from the probabilities of life, according to the Northampton bills of mortality; the mode of calculating them is explained by Dr. Price, in his Treatise on Reversionary Payments, and by Mr. Morgan, in a very useful work, entitled "The Doctrine of Annuities and Assurances on Lives and Survivorships, stated and explained."

Persons who are engaged in military or naval service, or who have not had the small-pox, or are subject to the gout, are charged an additional premium, supposed to be adequate to the additional risk.

Policies of assurance on lives generally contain clauses to the following effect.

Conditions of assurance made by persons on their own lives.—The assurance to be void, if the person whose life is assured shall depart beyond the limits of Europe, shall die upon the seas, (except in his Majesty's packets, passing between Great Britain and Ireland); or shall enter into, or engage in, any military or naval service whatever, without the previous consent of the assurers; or shall die by suicide, duelling, or the hand of justice; or shall not be, at the time the assurance is made, in good health.

Conditions of assurance made by persons on the lives of others.—The assurance to be void, if the person whose life is assured shall depart beyond the limits of Europe, shall die upon the seas, (except in his Majesty's packets, passing between Great Britain and Ireland); or shall enter into, or engage in, any military or naval service whatever, without the previous consent of the assurers; or shall not be, at the time the assurance is made, in good health.

Any person making an assurance on the life of another must be interested therein, agreeable to Act of 14th of Geo. III. chap. 48, which prohibits wagering, or speculative insurances.

ASTER, in botany, *starwort.* Class, Syngenesia Polygamia Superflua. Gen. char. cal. common, imbricate, the inner scales prominent a little at the end, lower ones spreading; cor. compound, radiate; corollules hermaphrodite, numerous in the disk; females ligulate, more than 10 in the ray; proper of the hermaphrodite, funnel-shaped, with a five-cleft spreading border: of the female ligulate, lanceolate, three-toothed, at length rolling back; stam. hermaphrodite; filaments five; capillary very short; anthers cylindric, tubulous; pist. germ oblong; style filiform, the length of the stamens; stigma bifid, spreading; females, germ and style the same; stigmas two, oblong revolute,; per. none; calyx scarcely changed; seeds solitary, oblong, ovate; down capillary; rec. naked, flattish. The species from the Cape, together with those not producing seeds in England, are propagated, by cuttings, any time during the summer. These should be planted in small pots filled with light earth, and plunged into an old hot-bed, where, if they are shaded from the sun, and gently watered, they will put out roots in six weeks, when they may be placed in the open air; and in about a month afterwards they should be separated, each in a small pot, and filled with light sandy earth. In October they must be removed into the green-house, and placed where they may enjoy as much free air as possible, but be secured from frosts or damps; so that they are much easier preserved in a glass-case, where they will have more light and air than in a green-house; but they must not be placed in a stove, for artificial heat will soon destroy the plants. The North American species, which make at least three-fifths of the genus, together with the Alpine and Italian asters, are easily propagated by parting the roots in autumn; they are most of them hardy, and will thrive in almost any soil and situation; for these reasons, and because they adorn the latter season with the abendance and variety of their spacious flowers, they are valuable plants, especially among shrubs, and in large ornamental plantations, properly mixed with golden rods, and other perennial, autumnal, hardy plants. The sorts most cultivated are, the grandiflorus, linifolius, linarifolius, tenuifolius, ericoides, dumosus, serotinus, alpinus, novæ angliæ, and punicius or altissimus. Some of the species prefer a shady situation and moist soil. They are apt to spread very much at the roots, so as to be troublesome, and the seeds of some are blown about, and come up like weeds. The Italian starwort has not been so much cultivated in England, since the great variety of American species has been introduced, though it is by no means inferior to the best of them. It is propagated by parting the roots soon after the plant is out of flower. The roots should not be removed oftener than every third year. Catesby's starwort, not multiplying fast by its roots, may be propagated in plenty by cuttings from the young shoots in May, which, if planted in light earth, and shaded from the sun, will flower the same year. When the annual starwort is once introduced, the seeds will scatter, and the plants come up without care. The China aster, being an annual plant, is propagated by seeds, which must be sown in the spring, on a warm border, or rather on a gentle hot-bed, just to bring up the plants. The North American species enumerated by Muhlenberg are 79 in number, and two doubtful, on the authority of Donn. Pursh describes 78 species.

ASTERIAS, in natural history, *starfish*, a genus of worms, of the order Mollusca. Body depressed, covered with a coriaceous crust, muricate, with tentacula, and grooved beneath; mouth central, five-rayed. There are more than 40 species, all inhabitants of the sea, and are marked with a rough, white, stony spot above: they easily renew parts which have been lost by violence, and fix themselves to the bottom by swimming on the back and bending the rays. There are three divisions; *viz.* A. lunate; B. stellate; and C. radiate. A. pulvillus is lubricous, with an entire simple margin, and is found in the North seas; body above convex, covered with a smooth sanguineous skin, transversely striate, beset towards the margin with soft, obtuse, white spines, about the size of a millet seed, and divided into 10 arcæ: the margin not articulate, but rough in the angles, with about 10 acute papillæ; beneath concave, smooth, whitish, with a rosy tinge, and hollowed by five grooves, each side covered with horizontal batons: it tinges warm water with a tawny colour. A. caput medusæ has five divided and subdivided rays; the disk and rays granulate; mouth depressed. This is a most curious animal, and inhabits the northern seas; the five rays dividing into two smaller ones, and each of these dividing again into two others; which mode of regular subdivision is continued to a vast extent, gradually decreasing in size, till at length the ramifications amount to many thousands, forming a beautiful net-work. Its colour is sometimes pale or reddish white, sometimes brown.

ASTERISM, in astronomy, the same with constellation. See CONSTELLATION.

ASTEROIDS, in astronomy, a name given by Dr. Herschell to the new planets, Ceres, Juno, Pallas, and Vesta, lately discovered: and which he defines as celestial bodies, which move in orbits either of little or of considerable eccentricity round the sun, the plane of which may be inclined to the ecliptic in any angle whatsoever. This motion may be direct or retrograde; and they may or may not have considerable atmospheres, very small comas, disks, or nuclei. According to the definitions which he premises, planets are celestial bodies, of a considerable size and small eccentricity of orbit, moving in planes that do not deviate many degrees from that of the earth, in a direct course, and in orbits at considerable distances from each other, with atmospheres of considerable extent; but bearing hardly any sensible proportion to their diameters, and having satellites or rings: and comets are very small celestial bodies, moving in directions wholly undetermined, and in very eccentric or apparently parabolic orbits, situated in every variety of position, and having very extensive atmospheres. Dr Herschell, having compared the newly discovered stars by the criteria introduced in the above definitions, maintains, that they differ in so many respects from both planets and comets, as to warrant his not referring them to either of these two classes.

ASTHMA, in medicine, a painful, difficult, and laborious respiration. See MEDICINE.

ASTRÆA, in astronomy, the same with Virgo. See VIRGO.

ASTRAGAL, in architecture, the neck moulding of a column, composed of a beed and fillet.

ASTRAGAL, in gunnery, a round moulding encompassing a cannon, about half a foot from its mouth.

ASTRAGALUS, *milk-vetch*, in botany, a genus of the Diadelphia Decandria class of plants, with a papilionaceous flower, and bilocular-podded fruit, containing kidney-like seeds. There are upwards of 60 species; all of which may be raised from seeds. They are in general hardy, and require no other care but to draw the plants out when they come up too thick, leaving them at least eighteen inches asunder. The American species are 5 in unmber.

ASTRAGALUS, in anatomy, called also the *talus*, is the superior and first bone of the foot, according to its natural situation and connection with the leg, being articulated with the tibia and fibula, and with the calcaneum; having its head formed for the articulation with the os naviculare.

ASTRAL, something belonging to or connected with the stars: thus, astral year is the same with sideral year.

ASTRANTIA, *black master-wort*, in botany, a genus of umbelliferous plants, belonging to the Pentandria Digynia class of Linnæus, the flower of which is rosaceous, and collected into a sort of head; and its fruit is oval, obtuse, coronated, and striated.

ASTROLABE, an instrument for taking the altitude of the sun or stars at sea, being a large brass ring, the limb of which, or a convenient part thereof, is divided into degrees and minutes, with a moveable index, which turns upon the centre, and turns two sights: at the zenith is a ring to hang it by in time of observation, when you need only turn the index to the sun, that the rays may pass freely through both sights, and the edge of the index cuts the altitude upon the divided limb. This instrument, though not much in use now, if well made, and of great weight, that it may hang the steadier, is as good as most instruments that are used at sea for taking altitudes, especially between the tropics, when the sun comes near the zenith, and in calm weather.

ASTROLOGY, a conjectural and truly absurd science, which teaches to judge of the effects and influences of the stars, and to foretel future events by the situation and different aspects of the heavenly bodies. It may be divided into two branches, natural and judiciary; the former being the prediction of natural effects, as the changes of weather, winds, storms, hurricanes, thunder, floods, earthquakes, &c. and the latter, that which pretends to foretel moral events, or such as have a dependence on the freedom of the will.

ASTRONIUM, in botany, a genus of the Dioecia Pentandria class and order of plants. The essential character is, male, calyx five-leaved; corol five-petalled. Female, calyx five-leaved; corol five-petalled; styles three, and one seed. There is but one species, the A. graveolens, an upright tree, from 12 to 30 feet in height, abounding every where in a slightly glutinous terebinthine juice. After the fruits in the female, and the flowers in the male, plant have fallen off, new branches are put forth. The flowers are small and red, the calyxes are expanded into stars, nearly an inch in diameter. It is native in the woods about Carthagena in New Spain.

ASTRONOMY, is the science which treats of the motions, periods, eclipses, magnitudes, &c. of the heavenly bodies, of the laws by which these are regulated, and of the causes on which they depend. It is unquestionably the most sublime of all the sciences. No subject has been longer or more successfully studied. Although it may be interesting to take a brief sketch of the history of this science, yet there can be no comparison drawn between the wide observations of the earlier observers, and the precision and general views of modern astronomers. To ascertain the real motions of the heavenly bodies was a difficult task, and required the united observations of many ages. To ascertain the laws and causes of these motions demanded the exertions of powers almost beyond the reach of the human faculties. This has, however, been accomplished, and it has been demonstrated, that the most minute movements of the heavenly bodies depend upon the same general law with the rest, and to be the consequence of it. Astronomy has therefore been highly regarded, as exhibiting one of the most remarkable instances of the extent and powers of the reasoning faculties. It has, moreover, conferred upon mankind the greatest benefits, in many respects, as will be shewn in the course of the present work, and may be properly considered as the teacher and guide of the art of navigation.

The early history of astronomy admits of no regular elucidation. It is probable that some knowledge of the kind must have been nearly coeval with the human race, as well from motives of curiosity, as from the connection which it has with the common concerns of life. Traces of it have accordingly been found among various nations, remote from each other, which shew that the most remarkable phenomena must have been observed, and a knowledge of them disseminated, at a very remote period. But in what age or country the science first originated, or by whom it was in those early times methodized and improved, is not now known. Such, however, as wish for every information that the subject admits of, we refer to the learned and very elaborate history of ancient and modern astronomy, by M. Bailly, a man of the highest reputation in the scientific world, and who was basely and cruelly murdered in the zenith of his celebrity, by the bloodthirsty Robespierre, whose savage ambition was, to efface from the earth every thing great, virtuous, and excellent.

M. Bailly endeavours to trace the origin of astronomy among the Chaldeans, Egyptians, Persians, Indians, and Chinese, to a very early period. From the researches which he has made on this subject, he is led to conclude that the knowledge common to the whole of those nations has been derived from the same original source; namely, a most ancient and highly cultivated people of Asia, of whose memory every trace is now extinct; but who have been the parent instructors of all around them. The situation of this ancient people he conjectures to have been in Siberia, about the 50th degree of north latitude. Among various other coincidences, he observes that many of the European and Asiatic nations attribute their origin to that quarter, where the civil and religious rites, common to each, were probably first formed.

Without going farther back, we may observe, that the Egyptians were early cultivators of this science, and that among the Greeks, Thales, who travelled into Egypt, and who was the founder of the Ionian sect, appears to have been the first who taught his countrymen the globular figure of the earth, the obliquity of the ecliptic, and the causes of solar and lunar eclipses; which latter phænomena he is also said to have been able to predict. Thales had for his successors, Anaximander, Anaximenes, and Anaxagoras, to the first of whom is attributed the invention of the gnomon and geographical charts; but for which he was probably indebted to the Egyptians. He is also said to have maintained that the sun was a mass of fire as large as the earth, which, though far below the truth with respect to size, was an opinion, for those early times, that does its author much credit, though to him, as in the case of Galileo, the truths he had discovered were the cause of persecution. Both himself and his children were proscribed by the Athenians for his attempting to subject the works of the gods to immutable laws; and his life would have paid the sacrifice of his temerity, but for the care of Pericles, his friend and disciple, who got his sentence of death changed into exile. Next after the Ionian school was that of Pythagoras, who was born at Samos, about the year 586 before the Christian æra, and who, in the celebrity he acquired, far exceeded his predecessors. Like Thales, he visited Egypt, and afterwards the Brachmans of India, from whom he is supposed to have obtained many of the astronomical truths which he brought with him into Italy, to which country he was obliged to retire, on account of the despotism which then prevailed at Athens. Here he first taught the true system of the world, which many centuries after, was revived by Copernicus: but hid his doctrines from the vulgar, in imitation of the Egyptian priests, who had been his instructors. It was even thought, in this school, that the planets were inhabited bodies, like the earth; and that the stars, which are disseminated through infinite space, are suns, and the centres of other planetary systems. They also considered the comets as permanent bodies, moving round the sun; and not as perishing meteors, formed in the atmosphere, as they were thought to be in after times. From this time to the foundation of the school of Alexandria, the history of astronomy among the Greeks offers nothing remarkable, except some attempts of Eudoxus to explain the celestial phænomena: and the celebrated cycle of 19 years, which had been imagined by Meton, in order to conciliate the solar and lunar motions. This is the most accurate period, for a short interval of time, that could have been devised, for embracing an exact number of revolutions of these two luminaries; and is so simple and useful, that when Meton proposed it to the Greeks, assembled at the Olympic games, as the basis of their calendar, it was received with great approbation, and unanimously adopted by all their colonies. In the school of Alexandria, we see, for the first time, a combined system of observations, made with instruments proper for measuring angles, and calculated trigonometrically. Astronomy accordingly took a new form, which succeeding ages have only brought to greater perfection. The position of the stars began at this time to be determined; they traced the course of the planets with great care; and the inequalities of the solar and lunar motions became better known. It was, in short, in this celebrated school, that a new system of astronomy arose, which embraced the whole of the celestial motions; and though inferior to that of Pythagoras, and even false in theory, it afforded the means, by the numerous observations which it furnished, of detecting its own fallacy, and of enabling astronomers in later times to discover the true system of nature. It was from their observations of the principal zodiacal stars, that Hipparchus was led to discover the precision of the equinoxes; and Ptolemy also founded upon them his theory of the motions of the planets. Next after these was Aristarchus, of Samos, who made the most delicate elements of the science the objects of his research. Among other things of this kind, he attempted to determine the magnitude and distance of the sun; and though, as may be supposed, the results he obtained were considerably wide of the truth, the methods he employed to resolve these difficult problems do great honour to his genius. The celebrity of his successor, Eratosthenes, arises chiefly from his attempt to measure the earth, and his observations on the obliquity of the ecliptic. Having remarked, at Syene, a well, which was enlightened to its bottom by the sun, on the day of the summer solstice, he observed the meredian height of the sun on the same day at Alexandria, and found that the celestial arc contained between the two places was the 50th part of the whole circumference; and as their distance was estimated at 500 stadia, he fixed the length of a great circle of the earth at 250,000: but as the length of the stadium employed by this astronomer is not known, we cannot appreciate the exactness of his measurement. Among others who cultivated and improved this science we may also mention the celebrated Archimedes, who constructed a kind of planetarium, or orrery, for representing the principal phænomena of heavenly bodies. But of all the astronomers of antiquity, Hipparchus of Bithynia is the one, who, by the number and precision of his observations, as well as by the important result which he derived from them, is the most entitled to our esteem. He flourished at Alexandria about the year 162 before the Christian æra; and began his astronomical labours by attempting to determine, with more exactness than had hitherto been done, the length of the tropical year, which he fixed at 365 days, 5 hours, and 55 minutes, being nearly 4½ minutes too great. Like most of his predecessors, he founded his system upon an uniform circular motion of the sun; but, instead of placing the earth in the centre of the solar orbit, he removed it to the distance of $\frac{1}{24}$th part of the radius, and fixed the apogee to the sixth degree of Gemini. By means of these data, he formed the first solar tables of which any mention is made in the history of astronomy; and though defective, and even erroneous in principle, they are a durable monument of his genius, which three centuries afterwards were respected by Ptolemy, without his presuming to alter them. The great astronomer next considered the motions of the moon, and endeavoured to measure the exact time of her revolution, by a comparison of ancient eclipses. He also determined the eccentricity and inclination of her orbit, as well as the motion of her nodes and apogee; and calculated all the eclipses that were to happen for 600 years to come.

Between the time of Hipparchus and Ptolemy, the chief observers of any note are, Agrippa, Menelaus, and Theon; the two latter of which are better known as geometricians than astronomers. We remark, however, in this interval, the reformation of the calendar by Julius Cæsar, and a more exact knowledge of the flux and reflux of the ocean. We pass over the dark ages, and observe that Frederic II. about 1230, set himself to restore some decayed universities, and founding a new one at Vienna. He also caused the works of Aristotle, and Ptolemy's Almagest, to be translated into Latin; from which latter circumstance we may date the revival of astronomy in Europe. Two years after this, John of Halifax, commonly known by the name of Sacro Bosco, compiled, from Ptolemy, Albategnius, Alfraganus, and other Arabic astronomers, his work "De Sphæra," which continued in great estimation for more than 300 years afterwards, and was honoured with commentaries by Clavius, and other learned men. Alphonsus, King of Castile, may also be reckoned as one of the most zealous encouragers and protectors of this science; though, being but ill seconded by the astronomers of that time, the tables which he published were not found to answer the great expense which attended them. See ALMAGEST.

About the same period also Roger Bacon, an English monk, besides many learned works of various kinds, wrote several treatises on astronomy; after which but little progress was made in the science till the time of Purbach, Regiomontanus, and Walther, who all flourished about the end of the fifteenth century, and by their labours prepared the way for the great discoveries which followed. Regiomontanus, in particular, who was born at Koningsberg, a town of Franconia, in 1426, and whose proper name was John Muller, rendered considerable services to astronomy, not only by his observations and writings, but by his trigonometrical tables of sines and tangents, which he computed to a radius of 1,000,000 for every minute of the quadrant, and by this means greatly facilitated astronomical computations. Next after these was Nicholaus Copernicus, the celebrated restorer of the old Pythagorean system of the world, which had been now set aside ever since the time of Ptolemy. He was born at Thorn, in Polish Prussia, in 1473, and having gone through a regular course of studies at Cracow, and afterwards at Rome, he was made, by the interest of his uncle, who was bishop of Wormia, a canon of Frawenberg; in which peaceful retreat, after 36 years of observations and meditations, he established his theory of the motion of the earth, with such new and demonstrative arguments in its favour, that it has gradually prevailed from that time, and is now universally received by the learned throughout Europe. This great man, however, had not the satisfaction of witnessing the success of his undertaking; being threatened by the persecution of religious bigots on the one side, and with an obstinate and violent opposition from those who called themselves philosophers on the other, it was not without the greatest solicitations that he could be prevailed upon to give up his papers to his friends, with permission to make them public; but, from continued importunities of this kind, he at length complied, and his book, "De Revolutionibus Orbium Cœlestium," after being suppressed for many years, was at length published, and a copy of it brought to him a few hours before his death. From Copernicus we proceed to Tycho Brahe, the celebrated Danish astronomer, who was born in 1546, and began to manifest his taste for this science at the early age of 14. An eclipse of the sun, which happened in 1560, first attracted his attention, and the justness of the calculation which announced this phænomenon inspired him with a strong desire of understanding the principles upon which it was founded. But meeting with some opposition from his tutor, and a part of his family, to these pursuits, which probably served only to increase his attachment to them, he made a journey into Germany, where he formed connections, and entered into a correspondence with some of the most eminent astronomers of that country, particularly with the landgrave of Hesse, who received him in the most flattering manner, and recommended him to the notice of his sovereign. Becoming by this means better known, on his return to Denmark, Frederic II. gave him the little island of Huen, at the entrance of the Baltic, where he built an observatory, under the name of Uraniburg, and in which, during a course of 20 years, he made a prodigious number of observations. His tranquillity, however, in this happy retreat, was at length interrupted; for soon after the death of Frederic, which happened in 1596, he was deprived, through the aspersions of some envious and malevolent persons, of his pension and establishment, and was not even allowed to follow his pursuits at Copenhagen, a minister of that time, of the name of Walchendorp, having forbid him to continue his observations. Happily, however, he found a powerful protector in the Emperor Rodolphus II. who ordered him to be properly provided for at his own expense, and gave him a commodious house at

Prague. After residing in this city till the year 1601, he was taken off by a sudden death, in the midst of his labours, and at an age while he was yet capable of rendering great services to astronomy. This great man, as is well known, was the inventor of a kind of semi Ptolemaic system of astronomy, that was afterwards called by his name, and which he vainly endeavoured to establish, instead of the Copernican, or true system. But though he was not happy in this respect, he has been of great use to astronomy, by his numerous observations and discoveries.

Tycho Brahe, in the latter part of his life, had, for his disciple and assistant, the celebrated Kepler, who was born in 1571, at Wiel, in the duchy of Wirtemberg, and was one of those rare characters that appear in the world only at particular times, to prepare the way for new and important discoveries. Like his master Tycho, he appears to have attached himself to the science at a very early age; and if it be the privilege of genius to change received ideas, and to announce truths which had never before been discovered, he may justly be considered as one of the greatest men that had yet appeared. Hipparchus, Ptolemy, Tycho Brahe, and even Copernicus himself, were indebted for a great part of their knowledge to the Egyptians, Chaldeans, and Indians, who were their masters in this science; but Kepler, by his own talents and industry, has made discoveries, of which no traces are to be found in the annals of antiquity. See BRAHE.

This great man, after seventeen years of meditation and calculation, having had the idea of comparing them with the powers of the numbers by which they are expressed, he found that the squares of the times of the revolutions of the planets are to each other as the cubes of their mean distances from the sun; and that the same law applies equally to their satellites. See KEPLER.

At the same time also that Kepler, in Germany, was tracing the orbits of the planets, and settling the laws of their motions, Galileo (who was born at Pisa, in Italy, in 1564) was meditating upon the doctrine of motion in general, and investigating its principles; and from the admirable discoveries which he made in this branch of the physico-mechanical sciences, Newton and Huygens were afterwards enabled to derive the most brilliant and complete theories of all the planetary motions.

About this period, also, a fortunate accident produced the most marvellous instrument that human industry and sagacity could have ever hoped to discover; and which, by giving a far greater extension and precision to astronomical observations, shewed many irregularities and new phenomena, which had hitherto remained unknown. This invention was that of the telescope, which was no sooner known to Galileo, than he set himself about to improve it; and the discoveries he was by this means enabled to make were as new as they were surprising.

The face of the moon appeared full of cavities and asperities, resembling vallies and mountains. The sun, which had generally been considered as a globe of pure fire, was observed to be sullied by a number of dark spots, which appeared on various parts of his surface. A great number of new stars were discovered in every part of the heavens; the planet Jupiter was found to be attended with four moons, which moved round him in the same manner that our moon moves round the earth; the phases of Venus appeared like those of the moon, as had before been concluded by Copernicus, from his theory; and, in short, most of the observations he made furnished new proofs of the truth of the Copernican system. In publishing the discoveries which he had made with this new instrument, Galileo shewed, in the most incontestible manner, the annual and diurnal motion of the earth; which doctrine, however, was thought so alarming, that it was immediately declared heretical, by a congregation of cardinals, who were assembled upon the occasion; and its venerable author, one of the most virtuous and enlightened men of his age, was obliged to abjure, upon his knees, and in the most solemn manner, a truth, which nature and his own understanding had shewn him to be incontrovertible. After this, he was condemned to perpetual imprisonment; from which, however, at the end of a year, he was enlarged, by the solicitations of the grand duke; but, that he might not withdraw himself from the power of the inquisition, he was forbid to quit the territory of Florence, where he died in 1642; carrying with him the regrets of Europe, enlightened by his labours, and their indignation against the odious tribunal which had treated him so unworthily. See GALILEO.

The discoveries of Huygens succeeded those of Kepler and Galileo; and few men have, perhaps, merited more of the sciences, by the importance and sublimity of his researches. Among other things, his happy application of the pendulum to clocks is one of the most advantageous presents that was ever made to astronomy. He was also the first who found that the singular appearances of Saturn are produced by a ring, by which the planet is surrounded; and his assiduity in observing it led him to the discovery of one of its satellites.

About this epoch, astronomy began to be more generally cultivated and improved, in consequence of the establishment of several learned societies, which, by exciting a spirit of emulation and enterprise among their members, greatly contributed to the advancement of every branch of the mathematical and physical sciences.

The chief of these were, the Royal Society of London, and that of the Academy of Sciences of Paris; both of which have rendered great services to astronomy, as well by the eminent men they have produced, as by the zeal and ardour with which the science has been constantly promoted by them. Towards the latter part of the seventeenth century, and the beginning of the eighteenth, practical astronomy seems rather to have languished; but, at the same time, the theoretical part was carried to the highest degree of perfection by the immortal Newton, in his "Principia," and by the astronomy of David Gregory. About this time, also, clock and watch-work was greatly improved by Mr. Graham, who likewise constructed the old eight feet mural arch at the Royal Observatory at Greenwich, and the zenith sector of 24 feet radius, with which Dr. Bradley discovered the aberration of the fixed stars. The astronomical improvements in the last century have been chiefly owing to the greater perfection of instruments, and to the establishment of regular observatories in various parts of Europe. Romer, a celebrated Danish astronomer, first made use of a meridian telescope; and, by observing the eclipses of Jupiter's satellites, was led to his discovery of the motion of light, which he communicated to the Academy of Sciences at Paris, in 1675.

Mr. Flamsteed was also appointed the first astronomer royal at Greenwich, about the same time, where he observed all the celestial phœnomena for more than 44 years: and, as the fruits of his labours, published a catalogue of 3000 stars, with their places, to the year 1688, as also new solar tables, and a theory of the moon, according to Horrox. Cassini, also, the first French astronomer royal, greatly distinguished himself by his numerous observations on the sun, moon and planets, and by the improvements he made in the elements of their motions.

In 1719, Mr. Flamsteed was succeeded by Dr. Halley, the friend of Newton, and a man of the first eminence in all the classes of literature and science, who had been sent, at the early age of 21, to the island of St. Helena, to observe the southern stars, a catalogue of which he published in 1729; and a few years afterwards he gave to the public his "Synopsis Astronomiæ Cometicæ," in which he ventured to predict the return of a comet in 1758 or 1759.

On the death of Dr. Halley, in 1742, he was succeeded by Dr. Bradley, who has rendered himself highly celebrated by two of the finest discoveries that have ever been made in astronomy, the aberration of light, and the nutation of the earth's axis. Among other things, he also formed new and accurate tables of the motions of Jupiter's satellites, as well as the most correct table of refractions yet extant. Also, with a large transit instrument, and a new mural quadrant of eight feet radius, constructed by Bird, in 1750, he made an immense number of observations, for settling the places of all the stars in the British catalogue, together with nearly 150 places of the moon, the greater part of which he compared with Mayer's tables.

Dr. Bradley was succeeded in 1762, in his office of astronomer royal, by Mr. Bliss, but who, being in a declining state of health, died in 1765, and was succeeded by Nevil Maskelyne, D. D., the present astronomer royal, who has rendered considerable services to this science, by his publication of the "Nautical Almanac," the "Requisite Tables," &c.; and more particularly by the great assiduity and zeal he has displayed in bringing the lunar method of determining the longitude at sea into general practice.

Such was the state of astronomy, when Dr. Herschell, by augmenting the powers of telescopes beyond the most sanguine expectations, opened a scene altogether unlooked for. By this indefatigable observer, we are made acquainted with a new primary planet belonging to our system, called the Georgium Sidus, attended by six satellites, which he discovered on the 13th of March, 1781, and which, being at twice the distance of Saturn from the sun, has doubled the bounds formerly assigned to the solar system. We are also indebted to him for a variety of observations on several other interesting astronomical subjects; such as the discovery of two additional satellites to Saturn, of which the number is now seven; a new method of measuring the lunar mountains; the rotation of the planets on their axis; on the parallax of the fixed stars; catalogues of double, triple stars, &c.; of nebulæ; and of the proper motion of the sun and solar system; the accounts of which, together with many other valuable papers, he has communicated, from time to time, in different parts of the Philosophical Transactions. A new planet has been discovered by M Piazzi, of Palermo, between Mars and Jupiter, to which has been given the name of Ceres Ferdinandia; another by Dr. Olbers; a third and a fourth have also been discovered, which we shall briefly notice farther on.

OF THE APPARENT MOTIONS OF THE HEAVENLY BODIES.

Having given a very brief sketch of the history of this science, than which, few, if any, have higher claims to our veneration and regard, we proceed to consider the science itself, intending to present the reader with a popular outline of the study, freed as much as possible from mathematical principles, upon which it depends, but for which few, in comparison, can be supposed, from previous studies, to have any taste.

When we cast our eyes towards the heavens, we perceive a vast concave hemisphere, at an unknown distance, of which the eye seems to constitute the centre. The earth stretches at our feet like an immense plain, and appears to meet, and to bound, the heavenly hemisphere. The circle around, where the earth and heavens seem to meet and touch each other, is called the horizon. It is natural to imagine, that, besides the hemisphere which we perceive, there is another, exactly similar, concealed from our view by the earth, and that the earth therefore is suspended in the middle of this heavenly sphere, with all its inhabitants. A little observation turns this suspicion into certainty; for in a clear evening the heavenly hemisphere is seen studded with stars, and its appearance is changing every instant. New stars are continually rising in the east, while others are setting in the west. Those stars, that early in the evening are seen just above the eastern horizon, will at midnight be seen in the middle of the starry hemisphere, and may be traced moving gradually towards the west, till at length they sink below the horizon. If we look to the north, we perceive that many stars in that quarter never set at all, but move round and round, describing a complete circle in 24 hours: these describe their circles round a fixed point in the heavens, and the circles diminish more and more the nearer the star is to that point. This fixed point is called the north pole. There must be a similar fixed point in the southern hemisphere, called the south pole. In this way the heavenly sphere appears to turn round two fixed points, called the poles, once in every 24 hours. The imaginary line which joins the points is called the axis of the world. We shall endeavour to illustrate this by means of a figure.

Let H O (fig. 1. Plate II.) represent the circle of the horizon, seen edgeways, when it will appear as a straight line: let H P E R Q represent the complete sphere of the heavens, of which H M O is supposed to be the visible hemisphere, and H N O the invisible hemisphere: then P will be the pole or fixed point among the stars, visible to us, round which they all appear to turn, and will be the opposite pole; the line P R will be the axis of the sphere.

To obtain precise views of the motions of the heavenly bodies, it is necessary to be able to assign precisely the place in which they are. This is done by means of several imaginary lines or circles, supposed to be described upon the surface of the sphere. These circles are divided into degrees, minutes, and seconds. The great circle of the sphere, Q E, which is perpendicular to the axis of the world, and of course 90° distant from either pole, is called the equator. The smaller circles which the stars describe, in consequence of their apparent diurnal motions, are called parallels, because they are parallel to the equator. The equator divides the heavenly sphere into two equal parts, the north and south; but, to be able to assign the position of the stars, it is necessary to have another circle passing through the poles, and cutting the equator perpendicularly; this is called the meridian, which is supposed to pass through the poles, and also directly over the head of the observer, M, and the point, N, exactly opposite to that. The first of these points is called the zenith, and the second is denominated the nadir. The meridian divides the circles described by the stars into two equal parts, and when they reach it, they are either at their greatest height above the horizon, or they are at their least height. The situation of the pole is readily found, it being precisely half way between the greatest and least height of those stars that never set. Since H M O, the visible part of the heavens, contains 180°, and it is 90° between the pole, P, and the equator, E Q; if, therefore, we take away P E from the semicircle H M O, there remains 90° for the other two arcs, P H and E O, that is, the elevation of the pole and the equator are, together, equal to 90°, so that the one being known, and subtracted from 90°, the other also is found. Hence it is known, that "the elevation of the pole at any place is the complement of the elevation of the equator," or what that elevation wants of 90°. Hence also the "elevation of the equator is equal to the distance from the pole, P, to the zenith, M;" for the elevation of the equator is the difference between that of the pole and 90°.

When we travel towards the north, we perceive that the north pole does not remain stationary, but rises towards the zenith, in proportion to the space that we pass over. On the contrary, it sinks just as much when we travel towards the south: from which we infer that the surface of the earth is not plane, as would appear to a superficial observer, but curved.

The heavenly bodies appear to describe a complete circle round the earth every 24 hours; but, besides these motions, which are common to them all, there are several which possess motions peculiar to themselves. The sun is farther towards the south during winter than during summer; he does not therefore keep the same station in the heavens, nor describe the same circle every day. The moon not only changes her form, diminishes, and increases, but, if she is observed in relation to certain fixed stars, it will be found that she proceeds to the eastward, making progress every day, till, in about a month, she makes a complete tour of the heavens. There are eight other stars, which are continually changing their place; sometimes they seem to be moving to the westward, sometimes to the eastward, and sometimes they appear stationary for a considerable time: these are called planets. There are other bodies which appear only occasionally, move for some time with very great velocity, and afterwards advance beyond the regions visible to us: these are comets, of which one is now (November, 1807,) apparent. The greater number of the heavenly bodies always retain the same, or nearly the same, relative distance from each other, and are, on that account, called fixed stars.

OF THE FIGURE AND MOTION OF THE EARTH.

The earth, as we have observed, was long considered as a large circular plane, spreading out on all sides to an indefinite distance; but it is now ascertained that it is of a spherical figure, nearly resembling that of a globe. The evidence for this fact is decisive, without having recourse to scientific principles, by considering that the celebrated navigators, Magellan, Sir Francis Drake, Lord Anson, and captain Cook, have all, at different times, sailed round the earth. They set out from European ports, and, by steering their course westward, arrived at length at the very place from whence they departed, which could not have happened, had the earth been of any other than a spherical or a globular figure. This form is also apparent, from the circular appearance of the sea itself, and the circumstances which attend large objects, when seen at a distance on its surface. For when a ship goes out to sea, we first lose sight of the hull, or body of the vessel, see fig. 4; afterwards that of the rigging; and at last can discern only the top of the mast, which is evidently owing to the convexity of the water between the eye and the object; for, otherwise, the largest and most conspicuous part would be visible the longest. Another proof is taken from the shadow of the earth upon the face of the moon, during the time of a lunar eclipse; for the moon, having no light but what it receives from the sun, and the earth being interposed between them, the moon must either wholly, or in part, become obscure. And since in every eclipse of this kind, which is not total, the obscure part always appears to be bounded by a circular line, the earth itself, for that reason, must be spherical; it being evident that none but a spherical body can, in all situations, cast a circular shadow.

It is not ascertained who was the first person that asserted the figure of the earth to be spherical, but the opinion is of very great antiquity. For, when Babylon was taken by Alexander the Great, it was known that the philosophers in that city had been long in the habit of calculating eclipses, which they could not have accomplished without a knowledge of the true figure of the earth. Thales, who flourished six centuries before the birth of Christ, predicted, according to the testimony of Herodotus, an eclipse of the sun. Hence it should seem, that in those early days, the globular figure of the earth had been, by the learned, investigated and credited. This being known, its magnitude would also soon be discovered: the solution of this apparently difficult problem engaged the attention of many great men about the same period; and though the measures which they have given are wide of the truth, and even very different from one another, yet this may be imputed to the inaccuracy of their instruments, and the want of mathematical knowledge, rather than to the impracticability in the thing itself. Without, however, entering upon this subject, we may observe, that the universe in general, as well as the solar system in particular, are in some measure connected with the motion of the globe that we inhabit. By the universe may be understood, the whole frame of nature to the utmost extent of the creation, and by the solar system is meant, that portion of it which comprehends the sun, planets, satellites, and comets. Of this system the sun is supposed to be in the centre, round which there are eleven planets continually revolving.

If we can form a notion of the manner in which the earth moves, we shall easily conceive the motions of all the rest of the planets, and by that means obtain a complete idea of the order and economy of the whole system. And in order to this, nothing more is necessary than to consider the common appearances of the heavens, which are constantly presented to our view, and attend to the consequences. For since it is well known that the sun and stars appear to move daily from east to west, and to return nearly to the same places in the heavens again in 24 hours, it follows, that they must really move, as they appear to do, or else that we ourselves must be moved, and attribute our motion to them: it being a self-evident principle, that if two things change their situation with respect to each other, one of them, at least, must have moved. But if this change be owing to the revolution of the stars, we must suppose them to be endowed with a motion so exceedingly swift, as to exceed all conception; since it is now known, by calculations founded on the surest observations, that their distances from us are so immense, and the orbits they have to run round so prodigiously great, that the nearest of them would move at least one hundred thousand miles in a minute. Now as nature never does that in a complicated and laborious manner, which may be done in a more simple and easy one, it is certainly more agreeable to reason, as well as to the power and wisdom of the Creator, that these effects should be produced by the motion of the earth; especially as such a motion will best account for all the celestial appearances, and at the same time preserve that beautiful simplicity and harmony, which is found to prevail in every other part of the creation. And this argument will appear still more forcible, if we compare the vast bulk of the celestial bodies with the bulk of the earth. For it is now well known, that the sun is above a million of times larger than the earth; and from the best modern observations it appears, that many of the stars are at least equally large. It is much more probable, therefore, that the earth revolves round its axis, with an easy natural motion, once in 24 hours, than that those immense bodies should be carried from one place to another with such incredible swiftness. Nor is it any objection to this rotation of the earth, that we are unable to perceive it. For as the motion of a ship at sea, when she sails swiftly over the smooth surface of the water, is almost imperceptible to the passengers and company on board, much more so must it be with such a large body as the earth, which has no impediments or obstacles of any kind to meet with in its way, or to disturb its motion. And in a manner equally easy may another objection be removed, which has frequently been brought against this doctrine. It has been asserted, that if the earth moved, a stone dropped from the top of a tower, or any other high building, would not fall just at the bottom of it, as the building must have advanced considerably forward during the time of the fall. But this is evidently a mistake; for it is well known, by repeated experiments, that if a body be projected from another body in motion, it will always partake of the motion of that other body. Thus, a stone dropped from the top of a mast, while the ship is under sail, is not left by the vessel, but falls exactly at the foot of the mast. And if a bottle of water be hung up in the cabin, with its neck downwards, it will empty itself, drop by drop, into another bottle placed exactly underneath it, though the ship shall have run many feet whilst each drop was in the air. This motion of the earth round its axis, which, from the instances already given, has been sufficiently proved, is called its diurnal or daily motion, and is that which occasions the regular return of day and night, and all the celestial appearances before mentioned. But there is also another motion of the earth, called its annual or yearly motion, which occasions the various vicissitudes of the seasons, summer, winter, spring, and autumn. And the proofs of this second motion may be easily gathered from celestial appearances, in nearly the same manner as the former. For as that luminary seems to move round the earth from east to west, in the space of a day, which is really owing to the diurnal revolution of the earth upon its axis, in a contrary direction; so likewise he seems to have an annual motion in the heavens, and to rise and set continually in different parts of them; which is certainly occasioned by the daily motion of the earth in its orbit, or path round the sun, which it completes in the space of a year.

OF THE SOLAR SYSTEM.

It is fully proved that the planets, with the earth which we inhabit, and also the moon, revolve round the sun, which is fixed in the centre of the system. There are two kinds of planets, primary and secondary. The first move round the sun, and respect him only as the centre of their motions. The secondary planets, called also satellites or moons, are smaller planets, revolving round the primary, while they, with the primary planets, about which they move, are carried round the sun. The planets move round the sun at various distances, some being much nearer to him than our earth, and others being much farther off. There are 11 primary planets, which are situated, with respect to their distances from the sun, as follows: Mercury ☿; Venus ♀; the Earth ⊕; Mars ♂; Ceres, Pallas, Juno, Vesta, Jupiter ♃; Saturn ♄; and the Herschel planet, or the Georgium Sidus ♅. (See plate I. Astronomy.) Of these our earth is accompanied by one moon, Jupiter has four moons, Saturn has seven moons, and the Herschel planet has six moons. None of these moons, except our own, can be seen without a good telescope. The other five planets do not appear to have any satellites, or moons. All the planets move round the sun from west to east, and in the same direction do the moons revolve round their primaries, excepting those of the Herschel planet, which seem to move in a contrary direction. The paths in which they move round the sun are called their orbits. These orbits are elliptical; but the eccentricity of the ellipses is so small, that they approach very nearly to circles. They perform their revolutions also in very different periods of time. The time of performing their revolutions is called their year. The planets are evidently opaque bodies, and they shine only by reflecting the light which they receive from the sun; for Mercury and Venus, when viewed by a telescope, often appear to be only partly illuminated, and have the appearance of our moon when she is cusped or horned, having the illumined part always turned towards the sun. From the appearance of the boundary of light and shadow upon their surfaces, we conclude that they are spherical; which is confirmed by some of them having been found to turn periodically on their axes. Venus and Mercury, being nearer to the sun than our earth, are called inferior planets, and all the rest, which are without the earth's orbit, are called superior planets. That the first go round the sun is certain, because they are seen sometimes passing between us and the sun, and sometimes they go behind it. That their orbits are within that of the earth is evident, because they are never seen in opposition to the sun, that is, appearing to rise from the horizon in the east when the sun is setting in the west, which is another proof that the earth is not the centre of celestial motions. On the contrary, the orbits of all the other planets surround that of the earth; for they sometimes are seen in opposition to the sun, and they never appear to be horned, but always nearly or quite full, though sometimes Mars appears a little gibbous, or somewhat deficient from full.

Since all the planets move round the sun in elliptical orbits, the sun itself is situated in one of the foci of each ellipse. That focus is called the lower focus. If we suppose the plain of the earth's orbit, which passes through the centre of the sun, to be extended in every direction as far as the fixed stars, it will mark out among them a great circle, which is the ecliptic; and with this the situations of the orbits of all the other planets are compared. The planes of the orbits of all the other planets must necessarily pass through the centre of the sun; but if extended as far as the fixed stars, they form circles different from one another, as also from the ecliptic; one part of each orbit being on the north, and the other on the south side of the ecliptic. Therefore the orbit of each planet cuts the ecliptic in two opposite points, which are called the nodes of that particular planet, and the nodes of one planet cut the ecliptic in planes different from the nodes of another planet. A line passing from one node of a planet to the opposite node, or the line in which the plane of the orbit cuts the ecliptic, is called the line of nodes. That node where the planet passes from the south to the north side of the ecliptic is called the ascending node, and the other is the descending node. The angle which the plane of a planet's orbit makes with the plane of the ecliptic is called the inclination of that planet's orbit. Thus, fig. 2. Plate II. where F represents the sun, the points A and B represent the nodes, and the line AB the line of nodes formed by the intersection of the planes of the orbits C and D. The angle E F G is the angle of inclination of the planes of the two orbits to each other. A line drawn from the lower focus of a planet's orbit (*viz.* where the sun is) to either end of the conjugate axis of its orbit, (which line is equal to half the transverse axis) is called the mean distance of the planet from the sun. But, according to some, the mean distance is a mean proportional between the two axes of that planet's orbit. The distance of either focus from the centre of the orbit is called its eccentricity. The two points in a planet's orbit, which are farthest and nearest to the body round which it moves, are called the apsides; the former of which is called the higher apsis, or aphelion; the latter is called the lower apsis, or perihelion. The diameter which joins these two points is called the line of the apsides. When the sun and moon are nearest to the earth, they are said to be in perigee. When at their greatest distance from the earth, they are said to be in apogee. When a planet is situated so as to be between the sun and the earth, or so that the sun is between the earth and the planet, then that planet is said to be in conjunction with the sun. When the earth is between the sun and any planet, then that planet is said to be in opposition. It is evident that the two inferior planets must have two conjunctions with the sun, and the superior planets can have only one, because they can never come between the earth and the sun. When a planet comes directly between us and the sun, it appears to pass over the sun's disc, or surface, and this is called the transit of the planet. When a planet moves from west to east, *viz.* according to the order of the signs, it is said to have direct motion, or to be in consequentia. Its retrograde motion, or motion in antecedentia, is when it appears to move from east to west, *viz.* contrary to the order of the signs. The place that any planet appears to occupy in the celestial hemisphere, when seen by an observer supposed to be placed in the sun, is called its heliocentric place. The place it occupies, when seen from the earth, is called its geocentric place.

The planets do not move with equal velocity in every part of their orbits, but they move faster when they are nearest to the sun, and slower in the remotest part of their orbits; and they all observe this remarkable law, that if a straight line be drawn from the planet to the sun, and this line be supposed to be carried along by the periodical motion of the planet, then the areas which are described by this right line and the path of the planet are proportional to the times of the planet's motion. That is, the area described in two days is double that which is described in one day, and a third part of that which is described in six days, though the arcs or portions of the orbit described are not in that ratio. The planets, being at different distances from the sun, perform their periodical revolutions in different times: but it has been found that the cubes of their mean distances are constantly as the squares of their periodical times; *viz.* of the times of their performing their periodical revolutions. These two last propositions were discovered by Kepler, by observations on the planets; but Sir Isaac Newton demonstrated, that it must have been so on the principle of gravitation, which formed the basis of his theory. This law of universal attraction, or gravitation, discovered by Newton, completely confirms the system of Copernicus, and accounts for all the phenomena which were inexplicable on any other theory. The sun, as the largest body in our system, forms the centre of attraction, round which all the planets move; but it must not be considered as the only body endued with attractive power, for all the planets also have the property of attraction, and act upon each other as well as upon the sun. The actual point therefore about which they move will be the common centre of gravity of all the bodies which are included in our system; that is, the sun, with the primary and secondary planets. But because the bulk of the sun greatly exceeds that of all the planets put together, this point is in the body of the sun. The attraction of the planets on each other also somewhat disturbs their motions, and causes some irregularities. It is this mutual attraction between them and the sun, that prevents them from flying off from their orbits by the centrifugal force which is generated by their revolving in a curve, while the centrifugal force keeps them from falling into the sun by the force of gravity, as they would do, if it were not for this motion impressed upon them. Thus these two powers balance each other, and preserve order and regularity in the system. It is well known, that if, when a body is projected in a straight line, it be acted upon by another force, drawing it towards a centre, it will be made to describe a curve, which will be either a circle or an ellipsis, according to the proportion between the projectile and centripetal force. If a planet at B (fig 3, Plate II.) gravitates, or is attracted towards the sun, S, so as to fall from B to *y*, in the time that the projectile force would have carried it from B to X, it will describe the curve B Y, by the combined action of these two forces, in the same time that the projectile force singly would have carried it from B to X, or the gravitating power singly have caused it to descend from B to *y*; and these two forces being duly proportioned, the planet obeying them both will move in the circle B Y T V. But if, whilst the projectile force would carry the planet from B to *b*, the sun's attraction should bring it down from B to 1, the gravitating power would then be too strong for the projectile force, and would cause the planet to describe the curve B C. When the planet comes to C, the gravitating power (which always increases as the square of the distance from the sun, S, diminishes) will be yet stronger for the projectile force, and by conspiring in some degree therewith, will accelerate the planet's motion all the way from C to K, causing it to describe the arcs B C, C D, D E, E F, &c. all in equal times. Having its motion thus accelerated, it thereby acquires so much centrifugal force, or tendency to fly off at K, in the line K *k*, as overcomes the sun's attraction; and the centrifugal force being too great to allow the planet to be brought nearer to the sun, or even to move round him in the circle *k l m n*, &c. it goes off, and ascends in the curve K L M N, &c. its motion decreasing as gradually from K to B as it increased from B to K, because the sun's attraction now acts against the planet's projectile motion just as much as it acted with it before. When the planet has got round to B, its projectile force is as much diminished from its mean state as it was augmented at K; and so the sun's attraction being more than sufficient to keep the planet from going off at B, it describes the same orbit over again, by virtue of the same forces or powers. A double projectile force will always balance a quadruple power of gravity. Let the planet at B have twice as great an impulse from thence towards X as it had before; that is, in the same length of time that it was projected from B to *b*, as in the last example; let it now be projected from B to *c*, and it will require four times as much gravity to retain it in its orbit; that is, it must fall as far as from B to 4 in the time that the projectile force would carry it from B to C, otherwise it would not describe the curve B D, as is evident from the figure. But in as much time as the planet moves from B to C, in the higher part of its orbit, it moves from I to K, or from K to L, in the lower part thereof; because, from the joint action of these two forces, it must always describe equal areas in equal times throughout its annual course. These areas are represented by the triangles B S C, C S D, D S E, E S F, &c. whose contents are equal to one another from the properties of the ellipsis. We have now given a general idea of the solar system; we shall next describe the bodies that compose it.

Of the sun The sun, as the most conspicuous and most important of all the heavenly bodies, would naturally claim the first place in the attention of astronomers. Accordingly, its motions were first studied, and they have had considerable influence on all the other branches of the science. That the sun has a motion of its own, independent of the apparent diurnal motion common to all the heavenly bodies, and in a direction contrary to that motion, is easily ascertained, by observing with care the changes which take place in the starry hemisphere during a complete year. If we note the time at which any particular star rises, we shall find that it rises somewhat sooner every successive day, till at last we lose it altogether in the west. But if we note it after the interval of a year, we shall find it rising precisely at the same hour as at first. Those stars which are situated nearly in the track of the sun, and which set soon after him, in a few evenings lose themselves altogether in his rays, and afterwards make their appearance in the east before sunrise. The sun then moves towards them in a direction contrary to his diurnal motion. It was by observations of this kind that the ancients ascertained his orbit. But at present this is done with greater precision, by observing every day the height of the sun when it reaches the meridian, and the interval of time which elapses between his passing the meridian and that of the stars. The first of these observations gives us the sun's daily motion northward or southward, in the direction of the meridian; and the second gives us his motion eastward in the direction of the parallels; and by combining the two together we obtain his orbit. The height of the sun from the horizon, when it passes the meridian, on the arch of the meridian between the sun and the horizon, is called the sun's altitude. The ancients ascertained the sun's altitude in the following manner:—They erected an upright pillar at the south end of a meridian line, and when the shadow of it exactly coincided with that line, they accurately measured the shadow's length, and then, knowing the height of the pillar, they found by an easy operation in plain trigonometry, the altitude of the sun's upper limb, whence, after allowing for the apparent semidiameter, the altitude of the sun's centre was known. But the methods now adopted are much more accurate. In a known latitude, a large astronomical quadrant, of six, eight, or ten feet radius, is fixed truly upon the meridian; the limb of this quadrant is divided into minutes and smaller subdivisions, by means of a vernier, and it is furnished with a telescope, having cross hairs, &c. turning properly upon the centre. By this instrument the altitude of the sun's centre is very carefully measured, and the proper deductions made. The orbit in which the sun appears to move is called the ecliptic. It does not coincide with the equator, but cuts it, forming with it an angle, which, in the year 1769, was determined by Dr. Maskelyne at 23° 28′ 10″, or 23°.46944. This angle is called the obliquity of the ecliptic.

It is known that the apparent motion of the sun in its orbit is not uniform. Observations made with precision, have ascertained, that the sun moves fastest in the point of his orbit situated near the winter solstice, and slowest in the opposite point of his orbit near the summer solstice. When in the first point, the sun moves in 24 hours 1°.01943; in the second point he moves only 0°.95319. The daily motion of the sun is constantly varying in every place of its orbit between these two points. The medium of the two is 0°.98632, or 59′ 11″, which is the daily motion of the sun about the beginning of October and April. It has been ascertained that the variation in the angular velocity of the sun is very nearly proportional to the mean angular distance of it from the point of its orbit where its velocity is greatest. It is natural to think, that the distance of the sun from the earth varies as well as its angular velocity. This is demonstrated by measuring the apparent diameter of the sun. Its diameter increases and diminishes in the same manner, and at the same time, with its angular velocity, but in a ratio twice as small. In the beginning of January, his apparent diameter is about 32′ 39″, and at the beginning of July it is about 31′ 34″, or more exactly, according to De la Place, 32′ 35″ = 1955″ in the first case, and 31′ 18″ = 1878″ in the second. Opticians have demonstrated, that the distance of any body is always reciprocally as its apparent diameter. The sun must follow the same law; therefore its distance from the earth increases in the same proportion that its apparent diameter diminishes. In that point of the orbit in which the sun is nearest the earth, his apparent diameter is greatest, and his motion swiftest; but when he is in the opposite point, both his diameter and the rapidity of his motion are the smallest possible.

To determine the distance of the sun from the earth has always been an interesting problem to astronomers, and they have tried every method which astronomy or geometry possesses, in order to resolve it. The amplest and most natural is that which mathematicians employ to measure distant terrestrial objects. From the two extremities of a base, whose length is known, the angles which the visual rays from the object, whose distance is to be measured, make with the base, are measured by means of a quadrant; their sum subtracted from 180° gives the angle which these rays form at the object where they intersect. This angle is called the parallax, and when it is once known, it is easy, by means of trigonometry, to ascertain the distance of the object. Let A B, in fig. 4, be the given base, and C the object whose distance we wish to ascertain. The angles C A B and C B A, formed by the rays C A and C B with the base, may be ascertained by observation; and their sum subtracted from 180° leaves the angle A C B, which is the parallax of the object C. It gives us the apparent size of the base A B, as seen from C. When this method is applied to the sun, it is necessary to have the largest possible base. Let us suppose two observers on the same meridian, observing at the same instant the meridian altitude of the centre of the sun, and his distance from the same pole. The difference of the two distances observed will be the angle under which the line which separates the observers will be seen from the centre of the sun. The position of the observers gives this line in parts of the earth's radius. Hence it is easy to determine, by observation, the angle at which the semidiameter of the earth would be seen from the centre of the sun. This angle is the sun's parallax. But it is too small to be determined with precision by that method. We can only conclude from it, that the sun's distance from the earth is at least equal to 10,000 diameters of the earth. Other methods have been discovered for finding the parallax with much greater precision. It amounts very nearly to 8″.8: hence it follows, that the distance of the sun from the earth amounts to at least 23.405 semidiameters of the earth.

The sun was long considered, from its constant emanation of heat and light, as an immense globe of fire. When viewed through a telescope, several dark spots are visible on its surface, which are of various sizes and durations. From the motion of these spots, the sun has been found to move round its axis, and its axis is found to be inclined to the ecliptic. Various opinions have been formed respecting these spots; they have been considered as opaque islands in the liquid igneous matter, and by some as pits or cavities in the body of the sun. In 1788, Mr. King published a Dissertation on the Sun, in which he advanced, that the real body of the sun is less than its apparent diameter; that we never discern the real body of the sun itself, except when we behold its spots; that the sun is inhabited as well as our earth, and is not necessarily subject to burning heat; and that there is in reality no violent elementary heat existing in the rays of the sun themselves essentially, but that they produce heat only when they come into contact with the planetary bodies. Several years after this, Mr. Herschel published his theory of the nature of the sun, which is briefly as follows: he considers the sun as a most magnificent habitable globe, surrounded by a double set of clouds. Those which are nearest its opaque body are less bright, and more closely connected together, than those of the upper stratum, which form the luminous apparent globe we behold. This luminous external matter is of a phosphoric nature, having several accidental openings in it, through which we see the sun's body, or the more opaque clouds beneath. These openings form the spots that we see.

Mercury. This planet being the nearest to the sun, and the least in magnitude, is very seldom visible. It never appears more than a few degrees from the sun's disc, and is generally lost in the splendour of the solar beams. On this account astronomers have had few opportunities of making accurate observations upon it; no spots have been observed upon it, consequently the time of its rotation on its axis is not known. Being an inferior planet, it consequently must shew phases like the moon; and it never appears quite full to us. It is seen sometimes passing over the sun's disc, which is called its transit.

Venus is the brightest, and largest to appearance, of all the planets, and is distinguished from the rest by her superiority of lustre. It is generally called the Morning or Evening Star, according as it precedes or follows the apparent course of the sun. Some have thought that they could discover spots upon its disc, but Herschel has not been able to see them; consequently, the time of rotation round its axis is not decidedly known. Venus also appears with phases, and transits sometimes take place, which are of very great importance in astronomy.

The *Earth*, which we inhabit, is, as has been proved, a globular body; it is not, however, a perfect sphere, but a spheroid, having its equatorial diameter longer than the polar diameter, or axis. It is consequently flattest at the poles, and more protuberant at the equator. The diameter at the equator is 7893 English miles; that at the pole is 7928 miles. The surface of the earth is much diversified with mountains and vallies, land and water. The highest mountains in it are the Andes, in South America, some of which are about four miles in perpendicular altitude. About two-thirds of the globe is covered with water. In consequence of the earth's being a globe, people standing upon opposite sides of it must have their feet towards each other. When in this situation, they are called antipodes to each other. Hence it appears that there is no real up or down; for what is up to one country is down to another. It must seem strange to those who are ignorant of the shape of the earth, to suppose, that if we could bore a hole downwards, deep enough, we should come to the other side of the world, where we should find a surface and sky like our own; yet, if we reflect a moment, we shall perceive that this is perfectly true. As we are preserved in our situations by the power of attraction, which draws us towards the centre of the earth, we call that direction down which tends to the centre, and the contrary. We mentioned before that the earth has two motions, the one a diurnal motion round its own axis, the other an annual motion round the sun. It is the former which causes light and darkness, day and night; for when one side of the earth is turned towards the sun, it receives his rays, and is illuminated, causing day; on the contrary, when one side of the earth is turned from the sun, we are in darkness, and then we have night. We see, therefore, by how much more simple means this change is effected, than they imagined, who supposed that the earth was fixed, and that the immense globe of the sun was whirled round the earth with the amazing velocity that would be necessary. Twilight is owing to the refraction of the rays of light by our atmosphere, through which they pass, and which, by bending them, occasion some to arrive at a part of the earth that could not receive any direct rays from the sun. It is the annual motion of the earth round the sun which occasions the diversity of seasons. To understand this, we must observe, what has been already mentioned, that the axis of the earth is inclined to the plane of its orbit 23½°, and it keeps always parallel to itself; that is, it is always directed to the same star. Let fig. 5, Plate II, represent the earth in different parts of its elliptic orbit. In the spring, the circle which separates the light from the dark side of the globe, called the terminator, passes through the poles *n*, *s*, as appears in the position A. The earth, then, in its diurnal rotation about its axis, has every part of its surface as long in light as in shade; therefore the days are equal to the nights all over the world, the sun being at that time vertical to the equatorial parts of the earth. As the earth proceeds in its orbit, and comes into the position B, the sun becomes vertical to those parts of the earth under the tropic, and the inhabitants of the northern hemisphere will enjoy summer, on account of the solar rays falling more perpendicularly upon them; they will also have their days longer than their nights, in proportion as they are more distant from the equator; and those within the polar circle, as will be perceived by the figure, will have constant daylight. At the same time the inhabitants of the southern hemisphere have winter, their days being shorter than their nights, in proportion as they are farther from the equator; and the inhabitants of the polar regions will have constant night. The earth then continues its course to the position C, when the terminator again passes through the poles, and the days and nights are equal. After this the earth advances to the position D, at which time the inhabitants of the northern hemisphere have winter, and their days are shorter than their nights. The positions B and D are the solstitial points, and A and C the equinoctial points; they are not equidistant from each other, because the sun is not in the centre, but in the focus of the ellipsis. In summer, when the earth is at B, the sun is farther from it than in the winter, when the earth is at D; and in fact, the diameter of the sun appears longer in winter than in summer. The difference of heat is not owing to the sun's being nearer to us, or more remote, but to the degree of obliquity with which its rays strike any part of the earth.

The *Moon* is, next to the sun, the most remarkable of the celestial objects. Its form is spherical, like that of the earth round which it revolves, and by which it is carried round the sun. Its orbit is also elliptical, having the earth in one of the foci of the ellipsis. The moon always keeps the same side towards the earth, shewing only at one time a little more of one side, and at another time a little more of the other side. When the moon is viewed through a good telescope, its surface appears covered with ridges, mountains, pits, and cavities of great variety. Some parts of its surface also reflect less light than the rest. It has been conjectured that the part which reflects the least light is water, and the brightest part land. The heights of the lunar mountains were formerly supposed to be much greater than those of our earth; but Dr. Herschel has demonstrated that very few are more than half a mile high, and the highest little more than a mile. Several volcanos, or burning mountains, have been discovered in it. It has been doubted whether the moon has an atmosphere like ours, but the latest observations appear to prove that it has. The moon is seen by means of the light which comes to it from the sun being reflected from it. Its changes or phases depend upon its situation relatively to the earth and the sun. When the moon is in opposition to the sun, the enlightened side is turned towards the earth, and it appears full; when the moon is in conjunction with the sun, its dark side is turned towards us, and it is invisible. As it proceeds in its orbit, a small part of the enlightened side is seen, and then we have a new moon; and we continue to see more and more of the enlightened side, as the moon approaches to the state of opposition, or full moon. The waning or decreasing of the moon takes place in the same manner, but in a contrary order. The earth must perform the same office to the moon that the moon does to us; and it will appear to the inhabitants of the moon (if there be any), like a very magnificent moon, being to them about 13 times as big as the moon to us, and it will also have the same changes or phases. The moon's motion is subject to many irregularities, on account of the inclination of its orbit to the plane of the ecliptic, and the attraction of the sun and the other planets.

The moon has scarcely any difference of seasons; her axis being almost perpendicular to the ecliptic. What is very singular, one half of her has no darkness at all, the earth constantly affording it a strong light in the sun's absence: while the other half has a fortnight's darkness, and a fortnight's light, by turns. Our earth, as we have already observed, is undoubtedly a moon to the moon; waxing and waning regularly, but affording her 13 times as much light as she does us. When she changes to us, the earth appears full to her; and when she is in her first quarter to us, the earth is in its third quarter to her; and *vice versa*. But from one half of the moon the earth is never seen at all: from the middle of the other half, it is always seen over head; turning round almost 30 times as quick as the moon does. From the circle which limits our view of the moon, only one half of the earth's side next her is seen; the other half being hid below the horizon of all places on that circle. To her, the earth seems to be the biggest body in the universe. As the earth turns round its axis, the several continents, seas, and islands, appear to the moon's inhabitants like so many spots of different forms and brightness, moving over its surface; but much fainter at some times than others, as our clouds cover them or leave them. By these spots the Lunarians can determine the time of the earth's diurnal motion, just as we do the motion of the sun: and perhaps they measure their time by the motion of the earth's spots; for they cannot have a truer dial. The moon's axis is so nearly perpendicular to the ecliptic, that the sun never removes sensibly from her equator; and the obliquity of her orbit, which is next to nothing as seen from the sun, cannot cause the sun to decline sensibly from her equator. Yet her inhabitants are not destitute of means for ascertaining the length of their year, though their method and ours must differ. For we can know the length of our year by the return of our equinoxes: but the Lunarians, having always equal day and night, must have recourse to another method; and we may suppose they measure their year, by observing when either of the poles of our earth begins to be enlightened, and the other to disappear, which is always at our equinoxes, they being conveniently situated for observing great tracts of land about our earth's poles, which are entirely unknown to us. Hence we may conclude, that the year is of the same absolute length both to the earth and moon, though very different as to the number of days; we having 365¼ natural days, and the Lunarians only $12\frac{1}{19}$, every day and night in the moon being as long as 29½ on the earth.

Mars is not so bright as Venus, nor even as Jupiter, though nearer to the sun. Its colour is a little reddish. Some spots have been observed upon its surface, from which its rotation round its axis, and the inclination of its axis to the plane of its orbit, have been determined. This planet sometimes appears gibbous, but never horned, like the moon, which shews that his orbit includes that of the earth, and that he shines by a borrowed light.

Ceres Ferdinandea is a very small planet, situated next without Mars: it was discovered on the first day of the present century, by Mr. Piazzi, an Italian astronomer.

Pallas is another very small planet, discovered by Dr. Olbers of Bremen, on the 28th of March, 1802. Two others have also been discovered, one by M. Harding, and the other by a pupil of Dr. Olbers. To these have been given the names of *Juno* and *Vesta*. These planets Dr. Herschel proposes to call asteroids, because they are so much smaller than any of the other planets.

Jupiter is the brightest planet next to Venus. When viewed by a telescope, several belts are observed across its disc, parallel to its equator: these belts are variable, and are supposed to be ranges of clouds in the atmosphere of the planet. Jupiter is surrounded by four moons, of different sizes, which move about it in different times. These moons are sometimes eclipsed by the shadow of Jupiter falling upon them; and the eclipses have been found of great use in determining the longitudes of different places on the earth: *Ex.* Suppose two observers of an eclipse, one at London, the other at the Cape of Good Hope, the eclipse will appear at the same instant of time to both; but being situated under different meridians, they count different hours, according to which the difference of their longitude is found. Thus, if an emersion of a satellite is observed at London $9^{h}\,33'\,12''$, and at another place $10^{h}\,46'\,45''$, the difference of time is $1^{h}\,13'\,33''$; of course that other place is 18° 23′ 15″ east of London.

The eclipses of Jupiter's satellites have been applied also to measure the velocity of light: by comparing the times of the apparent entrance and emersion of the satellites with tables calculated for the mean distances of the earth from the satellite, the visible emersion at the least distance is found to happen about eight minutes sooner; and at the greatest distance about eight minutes later than the tables: consequently, a ray of light is about 16 minutes in passing through the earth's orbit, or eight minutes in coming from the sun to the earth. If therefore the distance be 95,000,000 of miles, the velocity of light per second is equal to $\frac{95,000,000}{8 \times 60} =$ 198 thousand miles in a second nearly.

Saturn can hardly be seen by the naked eye. When examined by a telescope, it exhibits a very remarkable appearance. It is surrounded by a thin, flat, broad, luminous ring, which surrounds the body of the planet, but does not touch it. This ring casts a strong shadow upon the planet, and is divided into two, by a distinct line in the middle of its breadth. The rings are circular, but appear elliptical from being viewed obliquely.

According to Dr. Herschel, the dimensions of the rings, and the space between, are as follows:

	Miles.
Inner diameter of the smaller ring	146,345
Outside diameter of ditto . .	184,393
Inner diameter of the larger ring	190,248
Outside diameter of ditto . .	204,883
Breadth of the inner ring . .	20,000
Ditto . . . outer ring . .	7,200
Ditto of vacant space . . .	2,839

Besides this ring, Saturn has seven moons of different sizes, and its body is surrounded also by belts, like those of Jupiter.

The *Herschel planet*, with its six satellites, have been entirely discovered by Dr. Herschel. It cannot be seen without a telescope, but it does not require a powerful one. The satellites cannot be seen without the most powerful telescopes. We shall subjoin in the opposite page a table, which will contain a number of particulars relating to the planets, that will be found of great utility to the reader.

DR. MASKELYNE'S VIEW OF THE PLANETARY SYSTEM FOR 1801, DEC. 1.

	Apparent meandiameters, as seen from the earth.	Mean diameters, as seen from the sun.	Mean diameters in English miles.	Mean distances from the sun in round numbers of miles.	More accurate proportional numbers of the preceding mean distances.	Densities to that of water, which is 1.	Proportions of the quantities of matter.	Inclinations of orbits to the ecliptic in 1780.	Inclinations of axis to orbits.	Rotations diurnal, or round their own axis.	Eccentricities; the mean distances being 100000.
The Sun . .	32′ 1″.5		883246			$1\frac{2}{15}$	333928		82° 44′ 0″	25ᵈ 14ʰ 8ᵐ 0ˢ	
Murcury . .	10	16″	3224	37000000	38710	$9\frac{1}{6}$	0.1654	7° 0′ 0″			7955.4
Venus . . .	58	30	7687	68000000	72333	$5\frac{11}{18}$	0.8899	3 23 35		0 23 21	498
The Earth .		17.2	7911.73	95000000	100000	$4\frac{1}{2}$	1	0 0 0	66 32	1	1681.395
The Moon .	31 8	4.6	2180	95000000	100000	$5\frac{1}{2}$	0.025	5 .9 3 at a mean.	88 17	29 17 44 3	
Mars	27	10	4189	144000000	152369	$3\frac{2}{7}$	0.0875	1 51 0	59 22	0 24·39 22	14183.7
Ceres . . .	1		160	260000000	273550			10 37 56,6 in 1801.			8140 64
Pallas* . . .	0.5		80	266000000	279100			34 50 40 in 1801.			24630
Jupiter . .	39	37	89170	490000000	520279	$1\frac{1}{24}$	312.1	1 18 56 in 1780.	90 nearly.	0 9 55 37	25013.3
Saturn . . .	18	16	79042	900000000	954072	$0\frac{13}{35}$	97.76	2 29 50 in 1780.	60 probably.	0 10 16 2	53640.42
Herschel .	3 54	4	35112	1800000000	1908352	$0\frac{99}{100}$	16.84	0 46 20 in 1780.			90804

* Of the small planetary bodies, Juno and Vesta, enough is not yet known to reduce the facts to a tabular form.

OF COMETS.

Besides these planets already mentioned, there are some other bodies which revolve round the sun, called comets. They move in very eccentric ellipses, and their periods of revolution are so long, and so uncertainly known, that few are ever observed twice. They are only seen by us when they are in that part of their orbit which is nearest to the sun, and then they move so fast, that they soon become again invisible to us; the number of comets is unknown; numbers of small ones have been discovered by telescopes. Their distances are inconceivably great, and most of them move entirely beyond the planetary orbits, though some have descended below Mars. Their appearances are very different. Some appear only a faint vapour; others have a nucleus, or solid part, in the middle. When they approach the sun, they put forth the appearance of a beard, or tail, of luminous matter, which is sometimes of astonishing length. These tails are always directed from the sun. There are three comets, *viz.* of 1680, 1744, and 1759, that deserve to have a farther account given of them. The comet of 1680 was remarkable for its near approach to the sun; so near, that in its perihelion it was not above a sixth part of the diameter of the luminary from the surface thereof. The tail, like that of other comets, increased in length and brightness as it came nearer to the sun; and grew shorter and fainter, as it went farther from him and from the earth, till that and the comet were too far off to be any longer visible. The comet of 1744 was first seen at Lausanne, in Switzerland, December 13, 1743, N. S. From that time it increased in brightness and magnitude as it was coming nearer to the sun. Its diameter, when at the distance of the sun from us, measured about one minute, which brings it out equal to three times the diameter of the earth. It came so near Mercury, that if its attraction had been proportionable to its magnitude, it was thought probable it would have disturbed the motion of that planet. Mr. Betts, of Oxford, however, from some observations made there, and at Lord Macclesfield's observatory at Sherburn, found, that when the comet was at its least distance from Mercury, and almost twice as near the sun as that planet was, it was still distant from him a fifth part of the distance of the sun from the earth, and could therefore have no effect upon the planet's motions. He judged the comet to be at least equal in magnitude to the earth. He says, that in the evening of January 23, this comet appeared exceedingly distinct and bright, and the diameter of its nucleus nearly equal to that of Jupiter. Its tail extended above 16 degrees from its body; and was in length, supposing the sun's parallax 10″, no less than 33 millions of miles. Dr. Bevis, in the month of May, 1744, made four observations of Mercury, and found the places of that planet, calculated from correct tables, differed so little from the places observed, as to shew that the comet had no influence upon Mercury's motion. The nucleus, which had before been always round, on the 10th of February appeared oblong, in the direction of the tail, and seemed divided into two parts, by a black stroke in the middle. One of the parts had a sort of beard, brighter than the tail: this beard was surrounded by two unequal dark strokes, that separated the beard from the hair of the comet. The odd phenomena disappeared the next day, and nothing was seen but irregular obscure spaces like smoke in the middle of the tail; and the head resumed its natural form. February 15, the tail was divided into two branches; the eastern part about seven or eight degrees long, the western 24. On the 23d the tail began to be bent; it showed no tail till it was as near to the sun as the orbit of Mars; the tail grew longer as it approached nearer the sun; and at its greatest length was computed to equal a third part of the distance of the earth from the sun. The comet of 1759 did not make any considerable appearance, by reason of the unfavourable situation of the earth all the time its tail might otherwise have been conspicuous; the comet being then too near the sun to be seen by us; but deserves our particular consideration, as it was the first that ever had its return foretold. With respect to the real nature and use of the comets in the system, we are entirely unacquainted.

OF THE FIXED STARS.

The fixed stars are so called, because they are observed not to change their places in the heavens, as the planets do. They appear of an infinite variety of sizes; yet, for convenience, it is usual to class them into six or seven magnitudes; thus, they are called stars of the first, second, &c. magnitude. To the naked eye they appear innumerable, but this is only the consequence of their being scattered in so confused a manner, and our not being able to see them all at one view. The whole number of stars visible to the naked eye is about 3186. But seldom above one-third of that number can be seen at one time. From the earliest ages they have been divided into groups, or constellations, which have been called by the names of various animals and objects, from a supposed resemblance to them; such as the Great Bear, the Little Bear, the Swan, &c. The fixed stars are placed at a distance from us so great, that it cannot be ascertained by any means yet known: hence, they must shine by their own light, and not by the light which they receive from our sun, as the planets do. Though it has been formerly mentioned that the relative situations of the fixed stars do not vary, yet in the course of several ages some variations have been observed among them. Some of the larger stars have not the same precise situations that ancient observations attribute to them, and new stars have appeared, while some others, which have been described, are now no longer to be found. Some stars are likewise found to have a periodical increase and decrease. Many of the fixed stars, upon examination with the telescope, are found to consist of two. Besides the phenomena already mentioned, there are many nebulæ, or parts of the heavens, which are brighter than the rest. The most remarkable of these is a broad irregular zone or belt, called the Milky-way. There are others much smaller, and some so small, that they can be seen only by telescopes. If the telescope be directed to these nebulæ, they are resolvable into clusters of stars, which appear as white clouds in instruments of less force. Dr. Herschel, has rendered it highly probable, both from observation and well grounded conjecture, that the starry heavens is replete with these nebulæ or systems of stars, and that the Milky-way is that particular nebula in which our sun is placed. Reasoning analogically from the circumstances with which we are acquainted, we may deduce, that the universe consists of nebulæ or distinct systems of stars; that each nebula is composed of a prodigious number of suns or bodies, that shine by their own native splendour; and that each individual sun is destined to give light to numbers of worlds that revolve about it. What an august, what an amazing conception does this give of the works of the Creator? Instead of one world and one sun, we find thousands and thousands of suns, ranged around us at immense distances, all attended by innumerable worlds, all in rapid motion, yet calm, regular, and harmonious, invariably keeping the paths prescribed them; and these worlds peopled with myriads of intelligent beings, formed for endless progression in perfection and felicity. We shall now, in the form of a table, give the names of the constellations, and the number of stars observed in each by different astronomers.

THE ANCIENT CONSTELLATIONS.

		Ptolemy.	Tycho.	Hevelius.	Flamsteed.
Ursa Minor	The Little Bear	8	7	12	24
Ursa Major	The Great Bear	35	29	73	87
Draco	The Dragon	31	32	40	80
Cepheus	Cepheus	13	4	51	35
Bootes, *Arctophil*		23	18	52	54
Corona Borealis	The Northern Crown	8	8	8	21
Hercules, *Engonasin*	Hercules kneeling	29	28	45	113
Lyra	The harp	10	11	17	21
Cygnus, *Gallina*	The Swan	10	18	47	81
Cassiopeia	The Lady in her chair	13	26	37	55
Perseus	Perseus	29	29	46	59
Auriga	The Waggoner	14	9	40	66
Serpentarius, *Ophiuchus*	Serpentarius	29	15	40	74
Serpens	The Serpent	18	13	22	64
Sagitta	The Arrow	5	5	5	18
Aquila, *Vultur*	The Eagle	15	12	23	71
Antinous	Antinous		3	19	
Delphinus	The Dolphin	10	10	14	18
Equulus, *Equi sectio*	The Horse's Head	4	4	6	10
Pegasus, *Equus*	The Flying Horse	20	19	38	89
Andromeda	Andromeda	23	23	47	66
Triangulum	The Triangle	4	4	12	16

		Ptolemy.	Tycho.	Hevelius.	Flamsteed.
Aries	The Ram	18	21	27	66
Taurus	The Bull	44	43	51	141
Gemini	The Twins	25	25	38	85
Cancer	The Crab	23	15	29	83
Leo	The Lion	35	30	49	95
Coma Berenices	Berenice's Hair		14	21	43
Virgo	The Virgin	32	33	50	110
Libra, *Chelæ*	The Scales	17	10	20	51
Scorpio	The Scorpion	24	10	20	44
Sagittarius	The Archer	31	14	22	69
Capricornus	The Goat	28	28	29	51
Aquarius	The Water-bearer	45	41	47	108
Pisces	The Fishes	38	36	39	113
Cetus	The Whale	22	21	45	97
Orion	Orion	38	42	62	78
Eridanus, *Fluvius*	Eridanus, *the River*	34	10	27	84
Lepus	The Hare	12	13	16	19
Canis Major	The Great Dog	29	13	21	31
Canis Minor	The Little Dog	2	2	13	14
Argo Navis	The Ship	45	3	5	64
Hydra	The Hydra	27	19	31	60
Crater	The Cup	7	3	10	31
Corvus	The Crow	7	4		9
Centaurus	The Centaur	37			35
Lupus	The Wolf	19			24
Ara	The Altar	7			9
Corona Australis	The Southern Crown	13			12
Piscis Australis	The Southern Fish	18			24

THE NEW SOUTHERN CONSTELLATIONS.

Columba Noachi	Noah's Dove	10	Apis, *Musca*	The Bee or Fly	4
Rober Carolinum	The Royal Oak	12	Chamæleon	The Chameleon	10
Grus	The Crane	13	Triangulum Australe	The South Triangle	5
Phœnix	The Phenix	13	Piscis Volans, *Passer*	The Flying Fish	8
Indus	The Indian	12	Dorado, *Xiphias*	The Sword Fish	6
Pavo	The Peacock	14	Toucan	The American Goose	9
Apus, *Avis Indica*	The Bird of Paradise	11	Hydrus	The Water Snake	10

HEVELIUS'S CONSTELLATIONS MADE OUT OF THE UNFORMED STARS.

		Hevelius.	Flamsteed.
Lynx	The Lynx	19	44
Leo Minor	The Little Lyon	—	53
Asterion et Chara	The Greyhounds	23	25
Cerberus	Cerberus	4	
Vulpecula et Anser	The Fox and Goose	27	35
Scutum Sobieski	Sobieski's Shield	7	
Lacerta	The Lizard	10	16
Camelopardalus	The Camelopard	32	58
Monoceros	The Unicorn	19	31
Sextans	The Sextant	11	41

Several stars observed by the ancients are now no more to be seen, but are destroyed; and new ones have appeared, which were unknown to the ancients. Some of them have also disappeared for some time and again become visible. We are also assured, from the observations of astronomers, that some stars have been observed which never were seen before, and for a certain time they have distinguished themselves by their superlative lustre; but afterwards decreasing, they vanished by degrees, and were no more to be observed. One of these stars being first seen and observed by Hipparchus, the chief of the ancient astronomers, set him upon composing a catalogue of the fixed stars, that by it posterity might learn whether any of the stars perish, and others are produced afresh. After several ages, another new star appeared to Tycho Brahe, and the astronomers who were contemporary with him; which put him on the same design with Hipparchus, namely, the making a catalogue of the fixed stars. Of this, and other stars, which have appeared since that time, we have the following history by Dr. Halley. "The first new star in the chair of Cassiopeia was not seen by Cornelius Gemma on the 8th of November, 1572, who says, he, that night, considered that part of the heaven in a very serene sky, and saw it not; but that the next night, November 9, it appeared, with a splendour surpassing all the fixed stars, and scarce less bright than Venus. This was not seen by Tycho Brahe before the 11th of the same month; but from thence he assures us that it gradually decreased and died away; so as in March, 1574, after sixteen months, to be no longer visible; and at this day no signs of it remain. Its place in the sphere of fixed stars, by the acurate observations of the same Tycho, was 0^s 9° 17′ a 1^{ma} * ♈, with 35° 45′ north latitude. Such another star was seen, and observed, by the scholars of Kepler, to begin to appear on September 30, St. Vet. anno 1604, which was not to be seen the day before; but it broke out at once, with a lustre surpassing that of Jupiter, and, like the former, it died away gradually, and in much about the same time disappeared totally, there remaining no footsteps thereof in January, 1605-6. This was near the ecliptic, following the right leg of Serpentarius; and by the observations of Kepler, and others, was in 7^s 28° 00′ a 1^{ma} * ♈, with north latitude 1° 56′. These two seem to be of a distinct species from the rest, and nothing like them has appeared since. But between them, *viz.* in the year 1596, we have the first account of the wonderful star in Collo Ceti, seen by David Fabricius on the 14th of August, as bright as a star of the third magnitude, which has been since found to appear and disappear periodically; its period being precisely enough seven revolutions in six years, though it returns not always with the same lustre. Nor is it ever totally extinguished, but may at all times be seen with a six feet tube. This was singular in its kind, till that in Collo Cygni was discovered. It precedes the first star of Aries 1° 40′, with 15° 57′ south latitude. Another new star was first discovered by William Jansonius in the year 1600, in Pectore, or rather in Eductione Colli Cygni, which exceeded not the third magnitude. This, having continued some years, became at length so small, as to be thought by some to have disappeared entirely; but in the years 1657, 1658, and 1659, it again arose to the third magnitude; though soon after it decayed by degrees to the fifth or sixth magnitude, and at this day is to be seen as such in 9^s 18° 38′ a 1^{mo} * ♈, with 55° 29′ north latitude. A fifth new star was first seen by Hevelius in the year 1670, on July 15, St. Vet. as a star of the third magnitude; but by the beginning of October was scarce to be perceived by the naked eye. In April following it was again as bright as before, or rather greater than of the third magnitude, yet wholly disappeared about the middle of August. The next year, in March, 1672, it was seen again, but not exceeding the sixth magnitude; since when it has been no further visible, though we have frequently sought for its return; its place is 9^s 3° 17′ a 1^{ma} * ♈, and has lat. north 47° 28′. The sixth and last is that discovered by Mr. G. Kirch in the year 1686, and its period determined to be of 404½ days; and though it rarely exceeds the fifth magnitude, yet is very regular in its returns, as we found in the year 1714. Since then we have watched, as the absence of the moon and clearness of the weather would permit, to watch the first beginning of its appearance in a six feet tube, that, bearing a very great aperture, discovers most minute stars. And on June 15 last, it was first perceived like one of the very least telescopical stars; but in the rest of that month and July, it gradually increased, so as to become in August visible to the naked eye, and so continued till the month of September. After that, it again died away by degrees; and, on the 8th of December, at night, was scarcely discernible by the tube; and, as near as could be guessed, equal to what it was at its first appearance on June 25, so that this year it has been seen in all near six months, which is but little less than half its period; and the middle, and consequently the greatest brightness, falls about the 10th of September."

The late improvements in astronomy, and particularly those in the construction of telescopes, have now given astronomers an opportunity of observing the changes which take place among the stars with much greater accuracy than could be formerly done. In a paper in the

76th volume of the Philosophical Transactions, Mr. Edward Pigot gives a dissertation on the stars suspected by the astronomers of the last century to be changeable. For the greater accuracy in the investigation of his subject, he divides them into two classes; one containing those which are undoubtedly changeable, and the other those which are only suspected to be so. The former contains a list of 12 stars, from the first to the fourth magnitudes, including the new one which appeared in Cassiopeia in 1572, and that in Serpentarius in 1604: the other contains the names of 38 stars, of all magnitudes, from the first to the seventh. He is of opinion, that the celebrated new star in Cassiopeia is a periodical one, and that it returns once in 150 years. Keill is of the same opinion; and Mr. Pigot thinks, that its not being observed at the expiration of each period is no argument against the truth of that opinion; "since (says he) perhaps, as with most of the variables, it may, at different periods, have different degrees of lustre, so as sometimes only to increase to the ninth magnitude; and if this should be the case, its period is probably much shorter." For this reason, in September, 1782, he took a plan of the small stars near the place where it formerly appeared; but in four years had observed no alteration. The star in the neck of the Whale had also been examined by Mr. Pigot, from the end of 1782 to 1786, but he never found it exceed the sixth magnitude; though Mr. Goodricke had observed it on the ninth of August to be of the second magnitude, and on the third of September, the same year, it was of the third magnitude. Mr. Pigot deduced its period from its apparent equality with a smaller star in the neighbourhood, and thence found it to be 320, 328, and 337 days. The most remarkable of these changeable stars is that called Algol, in the head of Medusa. It had long been known to be variable; but its period was first ascertained by Mr Goodricke, of York, who began to observe it in the beginning of 1783. It changes continually from the first to the fourth magnitude; and the time taken up from its greatest diminution to its least is found, at a mean, to be 2^{d} 20^{h} 49^{m} and 3^{s}. During four hours it gradually diminishes in lustre, which it recovers during the succeeding four hours; and in the remaining part of the period, it invariably preserves its greatest lustre, and after the expiration of the term its diminution again commences. According to Mr. Pigot, the degree of brightness of this star, when at its minimum, is variable in different periods, and he is of the same opinion with regard to its brightness when at its full; but whether these differences return regularly or not has not been determined.

OF ECLIPSES.

When any one of the heavenly bodies is obscured or darkened by the shadow of another falling upon it, or by the interposition of any body, it is said to be eclipsed. The eclipses of the sun and moon are the most striking of any. They were formerly considered as ominous, and have often excited the dread and apprehension of the vulgar; but the improvement of science has shewn that they have no connection with future events; that they depend upon regular and invariable causes, and may be calculated and foretold with the greatest certainty. As the earth is an opaque body, enlightened only by the sun, it will cast a shadow towards that side which is farthest from the sun. If the sun and earth were of the same size, this shadow would be cylindrical, and would extend to an infinite distance: but as the sun is much larger than the earth, the shadow of the latter must be conical, or end in a point, (see fig. 6.) On the sides of this conical shadow, there is a diverging shadow, the density of which decreases in proportion as it recedes from the sides of the former conical shadow: this is called the penumbra. As the moon revolves round the earth sufficiently near to pass through the shadow of the earth, an eclipse must always take place when these three are all in one straight line. An eclipse of the moon can never happen but at the time of full moon; but, on account of the inclination of the moon's orbit to that of the earth, an eclipse cannot take place every full moon. When the moon passes entirely through the earth's shadow, the eclipse is total; but when only a part of it passes through the shadow, the eclipse is partial. The quantity of the moon's disc which is eclipsed (and the same thing is to be understood of that of the sun in a solar eclipse) is expressed by twelfth parts, called digits; that is, the disc is supposed to be divided by twelve parallel lines: then, if half the disc is eclipsed, the quantity of the eclipse is said to be six digits. When the diameter of the shadow through which the moon must pass is greater than the diameter of the moon, the quantity of the eclipse is said to be more than 12 digits;

thus, if the diameter of the moon is to that of the shadow as four to five, then the eclipse is said to be fifteen digits. The duration of a lunar eclipse is various, it sometimes lasts two or three hours. The eclipses of the sun are owing to a different cause than those of the moon. They are occasioned by the moon's coming directly between us and the sun, and therefore obstructing our view of it. When the moon happens to be in conjunction with the sun, or between the sun and the earth, *viz.* at the time of the new moons, the shadow of the moon falls upon the surface of the earth; hence, properly speaking, such eclipses should be called eclipses of the earth. But the whole disc of the earth cannot be involved in the shadow of the moon, because the moon is much smaller than the earth, and the shadow of the moon is conical. Thus, in Plate III. fig. 1, the rays of the sun, S, being intercepted by the moon, L, form the conical shadow C D G, which, falling upon the surface of the earth, entirely deprives that portion of it upon which it falls of the sun's light, and of course the inhabitants of that part of the earth will have a total eclipse of the sun. Beyond the dense conical shadow, C D G, there is a diverging half shadow, or penumbra, C D E F, which is occasioned by the moon's intercepting only a part of the sun's rays from those places which fall within this penumbral cone, and are out of the dense shadow. Thus, from the part of the earth Z the portion Y Y B of the sun only can be seen; consequently, the inhabitants of that part will have a partial eclipse. As the moon is not always at the same distance from the earth, it sometimes happens that the conical dense shadow does not reach the earth, as in fig. 2, and only the penumbral shadow falls upon it, the eclipse consequently is partial to every part of the earth. Those who are at the centre of the penumbra will lose sight of the centre of the sun by the interposition of the moon's body, which, subtending a smaller angle than the sun, will not entirely cover its surface, so that there will be a ring of light all round. The eclipse is then said to be annular. The satellites, or moons, are often eclipsed by the planets to which they belong. The eclipses of Jupiter's moons, as we have already observed, are very useful in ascertaining the longitude. When any of the planetary bodies disappear, by another coming before it, it is called an occultation. The occultations of the fixed stars by the moon are of great importance also in determining the longitudes of places.

OF THE TIDES.

The ebbing and flowing of the sea was first shewn by Kepler to be owing to the moon's attraction, and Newton demonstrated it upon the principles of gravitation. The attraction of the moon cannot alter the shape of the solid of the globe; but it has a considerable effect upon the fluid part, which it causes to assume a spheroidal figure, the longest axis being in the direction of the moon. It is therefore the highest tide at that place perpendicularly under the moon, or where the moon crosses the meredian. The sun also has some action upon the waters, though its attraction, on account of its distance, is not so strong as that of the moon. When the action of the sun and moon conspire together, the tide rises higher, and produces what are called spring tides. On the contrary, when they counteract each other, they produce neap tides. The ocean, it is well known, covers more than one-half of the globe; and this large body of water is found to be in continual motion, ebbing and flowing alternately, without the least intermission. What connection these motions have with the moon we shall see as we proceed; but at present it will be sufficient to observe, that they always follow a certain general rule. For instance, if the tide be now at high-water mark in any port or harbour which lies open to the ocean, it will presently subside, and flow regularly back for about six hours, when it will be found at low-water-mark. After this, it will again gradually advance for six hours, and then return back in the same time to its former situation; rising and falling, alternately, twice a day, or in the space of about twenty-four hours. And by observing the tides continually at the same place, they will always be found to follow the same rule; the time of high water upon the day of every new moon being nearly at the same hour, and three-quarters of an hour later every succeeding day. Let M (fig. 3.) represent the moon, O the centre of the earth, and A, B, C, &c. different points upon its surface, and let us suppose the earth to be entirely covered by the ocean. Then, because it is the property of a fluid for its parts to yield, and obey any force impressed upon them, it is clear that the moon M, acting upon the surface of the sea at the points A, B, C, &c. will elevate the waters in those parts, and draw them towards her, by her attractive power. But the point A being nearer to the moon than the point C, the attraction at A, will be greater than at C: and because the points B and D are at equal distances from the moon, the attraction at those points will also be equal; and so at any other intermediate points the attractive force will be different, according to their different distances from the moon.

From this example, then, it is sufficiently evident, that the attractive force of the moon, acting unequally upon different parts of the ocean, must occasion it to assume a different figure from what it would otherwise have, if there were no such unequal attractions. And since this attractive force is greatest on the part of the ocean which lies immediately under the moon, the waters will of course flow constantly to that part, and be elevated or depressed at different places, according as her situation changes with respect to those places. But, as the earth turns round on its axis, from the moon to the moon again, in about twenty-four hours and three-quarters, the flux and reflux will be necessarily retarded from day to day about three-quarters of an hour, which is agreeable to experience. It remains now to be explained, why they ebb and flow twice a day, or in the space of about twenty-four hours. When the moon passes the meridian of any place, or is at her greatest height above the horizon of that place, she will evidently attract and elevate the waters which lie immediately under her: but what is the reason, that, twelve hours afterwards, when she passes the meridian below the horizon, the waters at the same place are then also elevated? We know, from experience, that, whether the moon be in the zenith or nadir, the phenomenon is nearly the same; it being high water with us at the same time that it is high water with our antipodes.

Let M, (fig. 4.) represent the moon as before; O, the centre of the earth; and Z and N, those parts of the surface which are the nearest to the moon, and the farthest from her. Then, because the point Z is nearer to the moon than any other part of the hemisphere H Z R, it is evident that the waters will be more strongly attracted by her, about that point, than at others which are more remote; and since this attraction acts in a contrary direction to that of the earth, the waters in all parts, from H R to Z, must have their gravity or tendency towards the centre O diminished: and as this tendency is the least at the point Z, they will consequently stand higher there than in any other part of the hemisphere. Again, in the opposite hemisphere H N R, although the attraction of the moon conspires with that of the earth, yet, as it is known to decrease in proportion as the squares of the distances increase, it is plain that the joint influence of the two forces, taken together, will be less at the point N, on the side opposite to the moon, than at those parts which lie nearer to H R; and consequently, as the gravity of the waters, or their tendency towards the centre, is also the least at that point, they will be more elevated there than in any other part of the hemisphere; so that the attractive force of the moon will evidently raise the waters, both at that point of the surface which is nearest to her, and at that which is farthest from her, at the same time, as was to be shewn.

Following this system, then, it is to be observed, that at any port or harbour which lies open to the ocean, the action of the moon will tend to elevate the waters there, when she is on the meridian of that place, whether it be above the horizon or below it But the water cannot be raised at one place, without flowing from and being depressed at another; and these elevations and depressions will obviously be the greatest at opposite points of the earth's surface. When the moon raises the waters at Z and N, they will be depressed at H and R; and when they are raised by her at H and R, they will be depressed at Z and N. And as the moon passes over the meridian, and is in the horizon twice every day, there will therefore be two tides of flood, and two of ebb, in that time, at the interval of about six hours and eleven minutes each; which is exactly conformable to theory and experience.

From what has been hitherto said, it may be supposed, that the moon is the sole agent concerned in producing the tides. But it will be necessary to observe, before we quit the subject, that the influence of the sun would also produce a similar effect, though in a much less degree, than from his superior magnitude we should naturally be led to imagine. For it is not the entire actions of those bodies upon the whole globe of the earth that is here to be considered, but only the inequalities of those actions upon different parts of it. The whole attractive force of the sun is far superior to that of the moon; but, as his distance from the earth is nearly 400 times greater, the forces, with which he acts upon different parts of it, will be much nearer to equality than those of the moon; and consequently will have a less effect in producing any change of its figure. For it is to be observed, that, if all parts of the earth were equally attracted, they would suffer but little change in their mutual situations. That this doctrine may be still more clearly understood, let it be considered, that though the earth's diameter bears a considerable proportion to the distance of the earth from the moon, yet this diameter is almost nothing, when compared to the distance of the earth from the sun. The difference of the sun's attraction, therefore, on the sides of the earth under and opposite to him, will be much less than the difference of the moon's attraction on the sides of the earth under and opposite to her; and for this reason, the moon must raise the tides much higher than they can be raised by the sun. Newton calculated the effect of the sun's influence in this case, and found that it is about three times less than that of the moon. The action of the sun alone would therefore be sufficient to produce a flux and reflux of the sea; but the elevations and depressions occasioned by this means would be about three times less than those produced by the moon. The tides, then, are not the sole production of the moon, but of the joint forces of the sun and moon together: or, properly speaking, there are two tides, a solar one and a lunar one; which have a joint or opposite effect, according to the situation of the bodies which produce them. When the actions of the sun and moon conspire together, as at the time of new and full moon, the flux and reflux become more considerable; and in this case they are called the spring tides. But when one tends to elevate the waters, whilst the other depresses them, as at the moon's first and third quarters, the effect will be exactly the contrary; the flux and reflux, instead of being augmented, as before, will now be diminished; and they are then called the neap tides. But as this is a matter of some importance, it may be worth while to enter into a more minute explanation of it.

For this purpose, let S (fig 5) represent the sun, ZHNR the earth, and F C the moon, at her full and change. Then, because the sun, S, and the moon, C, are nearly in the same right line with the centre of the earth, O, their actions will conspire together, and raise the water about the zenith, Z, or the point immediately under them, to a greater height than if only one of these forces acted alone. But it has been shewn, that when the ocean is elevated at the zenith, Z, it is also elevated at the opposite point, or nadir, N, at the same time; and therefore, in this situation of the sun and moon, the tides will be augmented. Again, whilst the full moon, F, raises the waters at N and Z, directly under and opposite to her, the sun, S, acting in the same right line, will also raise the waters at the same points, Z and N, directly under and opposite to him; and therefore, in this situation also, the tides will be augmented, their joint effect being nearly the same at the change as at the full; and in both cases they occasion what are called the spring tides. Pursuing the illustration in the same way, let now F and T (fig. 6) be the moon in her first and third quarters, and the rest as before. Then, since the sun and moon act in the right lines S H and F T, which are nearly perpendicular to each other, their forces will tend to produce contrary effects; because the one raises the waters in that part where the other depresses them. The sun's attraction at R and H will diminish the effect of the moon's attraction at Z and N; so that the waters will rise a little at the points under and opposite to the sun, and fall as much at the points under and opposite to the moon; and of course the lunar tides will be diminished in those parts. This respects the moon only in her first quarter, at F; but the same reasoning will evidently hold, when applied to the moon in her third quarter, at T; for as the sun and moon still act in lines which are perpendicular to each other, they must produce the same diminution as before; and in both these cases they occasion what are called the neap tides. But it must be observed, that neither the spring nor neap tides happen when the sun and moon have the precise situations here mentioned; because, in this case, as in others of a similar kind, the actions do not produce the greatest effect when they are the strongest, but some time afterwards. The effects of the disturbing forces of the sun and moon depend, likewise, upon their respective distances from the earth, as well as upon their particular situations. For the less the distances are, the greater will be their effects; and, consequently, in winter, when the sun is nearer to the earth, the spring tides will be greater than in summer, when he is farther off; and the neap tides, on that account, will be less. For a like reason, as the moon moves in an elliptical orbit round the earth, and is nearer to us at some times than at others, the tides will at those times be greater, and at the opposite points of her orbit less. Some variations likewise take place in consequence of the different declinations of the sun and moon at different times. For if either of these luminaries were at the pole, it would occasion a constant elevation both there and at the opposite one, and a constant depression at the equator; so that as the sun and moon gradually decline from the equator, they lose their effect, and the tides become less; and when they are both in the equator, the tides of course become greater.

Astronomy is sometimes divided in books, with respect to its different states, into "new" and "old." The former refers to the art, as it stood under Ptolemy and his followers, with all the apparatus of solid orbs, epicycles, &c. &c. By new astronomy is meant the science, as it has been cultivated since the period in which Copernicus flourished. By that great man the constitution of the heavens was reduced to more simple, natural, and certain principles. The substance of the old astronomy is given by Tacquet, and of the new by Whiston, in his "Prelectiones Astronomicæ," published in 1707. The whole doctrine, both according to the ancients and moderns, is explained by Mercator, in his Institutiones Astron.

Having concluded this brief sketch of a very important science, we shall refer to other articles, in which many subjects will be discussed, that usually find place in a treatise of astronomy. Under the word Sun will be found some interesting speculations of Dr. Herschel; under that of Moon, an account of the methods of measuring its mountains, an explication of the harvest moon and horizontal moon. For *equation of time*, see Time; see also Earth, *figure of;* Ecliptic; Equinoxes, *precession of;* Galaxy; Gravitation; Nebulæ; Saturn, *ring of;* Astronomy, *practical;* and Astronomical *instruments:* See Observatory; Satellites; Transit; &c. &c. &c.

ASTROSCOPE, an instrument composed of two cones, having the constellations delineated on their surfaces, whereby the stars may be easily known.

ASYMETRY, in a general sense, the want of proportion between the parts of any thing, being the contrary of symmetry.

In mathematics it is used for what is more commonly called incommensurability, or the relation of two quantities which have no common measure, as between one and the square root of two, or as $1 : \sqrt{2}$, or the side and diagonal of a square.

ASYMPTOTE, in geometry, a line which continually approaches nearer to another; but though continued indefinitely will never meet with it: of these there are many kinds.

The term asymptotes is appropriated to right lines, which approach nearer and nearer to some curve, of which they are said to be the asymptotes; but if they and their curves are indefinitely continued, they will never meet.

Concerning asymptotes and asymptotical curves, it may be remarked, 1. That although such curves as have asymptotes are of the number of those which do not include a space; yet it is not true, on the other hand, that, wherever we have a curve of that nature, we have an asymptote also. 2. Of these curves that have an asymptote, some have only one, as the conchoid, cissoid, and logarithmic curve; and others two, as the hyperbola. 3. As a right line and a curve may be asymptotical to one another, so also may curves and curves: such are two parabolas, whose axes are in the same right line. 4. No right line can ever be an asymptote to a curve that is every where concave to that right line. 5. But a right line may be an asymptote to a mixed curve that is partly concave, and partly convex, towards the same line. And, 6. All curves that have one and the same common asymptote, are also asymptotical to one another. See Conic Sections.

ASYNDETON, in grammar, a figure which omits the conjunctions in a sentence, as in that verse of Virgil,

> *Ferte citi flammas, date vela, impellite remos.*

ATCHIEVEMENT, in heraldry, denotes the arms of a person, or family, together with all the exterior ornaments of the shield, as helmet, mantle, crest, scrolls, and motto, with such quarterings as may have been acquired by alliances, all marshalled in order.

ATHAMANTA, in botany, a genus of the Pentandria Digynia class of plants, the general corolla whereof is uniform; the partial one consists of five inflexo-cordated unequal petals; there is no pericarpium; the fruit is ovato-oblong, striated, and divisible into two parts; the seeds are two, oval, striated, and convex on the one side, and plain on the other: There are ten species.

ATHANASIA, in botany, a genus of the Syngenesia Polygamia Equalis class and order, and of the natural order of compound flowers. The essential character is, calyx imbricate; down chaffy, very short; receptacle chaffy. There are 20 species.

ATHEIST, is one who does not believe in the existence of a God. He attributes every thing to a fortuitous concourse of atoms. Plato distinguishes three sorts of Atheists. 1. Such as deny absolutely that there are any gods. 2. Others who allow their existence, but deny that they have any concern with human affairs; and, lastly, such as believe in gods and a providence, but think they are easily appeased, and remit the greatest of crimes for the smallest supplication. The first of these are the only true Atheists, and it has been doubted whether such persons really exist; yet it must be confessed, that, in the year 1619, Spinosa was burnt to death for having avowed his adherence to the opinion. We have many excellent works in opposition to Atheism, but not a single treatise written in its behalf. Those who wish to see Atheism confuted, may be referred to the sermons preached at Boyle's Lectures; to Abernethy's Discourses on the Attributes; and, above all, to Paley's Natural Theology. Newton, Boyle, Maclaurin, and others, among the most distinguished mathematicians and philosophers, have been among the ablest advocates for the existence of a God.

ATHENÆA, in botany, a genus of plants of the Octandria Monogynia class and order. Essential character: calyx coloured, five-parted; no corolla; bristles eight-feathered between the filaments; stigma five-parted; capsule globose, one-celled, three-valved; seeds three to five. There is one species, a branching shrub; stem four or five inches in diameter, covered with a wrinkled grey bark. The flowers come out in bundles from the axils; their calyx is white; capsule green, with a tinge of violet. The seeds are covered with a pulpy viscid membrane, of a scarlet colour; the bark, leaves, and fruits, are sharp and aromatic. The last are called by the Creoles *caffe diuble*. It is a native of Cayenne and the neighbouring continent of Guiana, a mile from the shore, in a sandy soil, flowering and bearing fruit in September.

ATHENÆUM, in antiquity, a public place wherein the professors of the liberal arts held their assemblies, the rhetoricians declaimed, and the poets rehearsed their performances.

ATHERINA, *silver-side*, in natural history, a genus of fishes of the order Abdominales. Head somewhat flattened over the upper-jaw; gill membrane six-rayed; body marked by a silver lateral stripe. There are five species: A. hespetus has an anal fin with about twelve rays; it inhabits the Mediterranean, European, and Red seas; about three or four inches long; body varied with a few black spots, and nearly pellucid. This species, which is named Athernos by the modern Greeks, is seen in vast shoals about the coasts of the islands in the Archipelago, and is easily taken in great quantities, by the simple device of trailing in the water a horse's tail or a piece of black-cloth fastened to the end of a pole, the fishes following all its motions, and suffering themselves to be drawn into some deep cavity formed by the rocks, when they are readily secured by means of a net, and may be taken at pleasure. At Southampton, England, they are to be had at almost all seasons, where they go by the name of Smelts. See Plate Pisces, fig. 4.

ATHWART, in naval affairs, across the line of the ship's course, as "We discovered a fleet standing athwart us," *i. e.* steering across our way.

ATHWART *hawse*, the situation of a ship when she is driven by any accident across the stem of another, whether they bear against, or at a small distance from, each other: the transverse position being principally understood.

ATLAS, in matters of literature, denotes a book of universal geography, containing maps of all the known parts of the world.

ATLAS, in commerce, a silk-satin, manufactured in the East-Indies. There are some plain, some striped, and some flowered; the flowers of which are either gold or silk. There are atlasses of all colours, but most of them false, especially the red and the crimson. The manufacture of them is admirable, the gold and silk being worked together after such a manner as no workmen in Europe can imitate; yet they are very far from having that fine gloss and lustre which the French know how to give their silk stuffs. In the Chinese manufactures of this sort, they gild paper on one side with leaf-gold, then cut it in long slips, and weave it into their silks, which makes them, with very little cost, look very rich and fine. The same slips are twisted or turned about silk threads so artificially, as to look finer than gold thread, though it be of no greater value.

ATMOSPHERE is that invisible elastic fluid which surrounds the earth to an unknown height, and encloses it on all sides. This fluid is essential to the existence of all animal and vegetable life, and even to the constitution of all kinds of matter whatever, without which they would not be what they are: for by it we literally may be said to live, move, and have our being: by insinuating itself into all the pores of bodies, it becomes the great spring of almost all the mutations to which the chemist and philosopher are witnesses in the changes of bodies. Without the atmosphere no animal could exist; vegetation would cease, and there would be neither rain nor refreshing dews to moisten the face of the ground; and though the sun and stars might be seen as bright specks, yet there would be little enjoyment of light, could we ourselves exist without it. Nature, indeed, and the constitutions and principles of matter, would be totally changed, if this fluid were wanting.

The mechanical force of the atmosphere is of great importance in the affairs of men, who employ it in the motion of their ships, in turning their mills, and in a thousand other ways connected with the arts of life. It was not till the time of Lord Bacon, who taught his countrymen how to investigate natural phenomena, that the atmosphere began to be investigated with any degree of precision. Galileo introduced the study by pointing out its weight; a subject that was soon after investigated more completely by Torricelli and others. Its density and elasticity were ascertained by Mr. Boyle and the academicians at Florence. Mariotte measured its dilatibility; Hooke, Newton, Boyle, and Derham, shewed its relation to light, to sound, and to electricity. Sir I. Newton explained the effect produced upon it by moisture, from which Halley attempted to explain the changes in its weight indicated by the barometer.

The atmosphere, we have said, envelops the whole surface of the earth, and if they were both at rest, then the figure of the atmosphere would be globular, because all the parts of the surface of a fluid in a state of rest must be equally removed from its centre. But as the earth and the surrounding parts of the atmosphere revolve uniformly together about their axis, the different parts of both have a centrifugal force, the tendency of which is more considerable, and that of the centripetal less, as the parts are more remote from the axis, and hence the figure of the atmosphere must become an oblate spheroid, since the parts that correspond to the equator are farther removed from the axis than the parts which correspond to the poles. The figure of the atmosphere must also, on another account, represent a flattened spheroid, namely, because the sun strikes more directly the air which encompasses the equator, and is comprehended between the two tropics, than that which pertains to the polar regions: hence it follows, that the mass of air, or part of the atmosphere adjoining to the poles, being less heated, cannot expand so much nor reach so high. Nevertheless, as the same force which contributes to elevate the air diminishes its gravity and pressure on the surface of the earth, higher columns of it about the equatorial parts, other circumstances being the same, may not be heavier than those about the poles. Mr. Kirwan observes, that in the natural state of the atmosphere, that is, when the barometer would, every where at the level of the sea, stand at 30 inches, the weight of the atmosphere at the surface of the sea, must be equal all over the globe; and in order to produce this equality, as the weight proceeds from its density and height, it must be lowest where the density is greatest, and highest where the density is least; that is, highest at the equator and lowest at the poles, with the intermediate gradations. On this and other accounts, in the highest regions of the atmosphere, the denser equatorial air not being supported by the collateral tropical columns, gradually flows over and rolls down to the north and south; these superior tides have been supposed to consist of hydrogen gas, inasmuch as it is much lighter than any other, and is generated in great plenty between the tropics; it is also supposed to furnish the matter of the auroræ borealis and australis.

With regard to the weight and pressure of the atmosphere, it is evident that the whole mass, in common with all other matter, must be endowed with weight and pressure: and it is found, by undeniable experiments, that the pressure of the atmosphere sustains a column of quicksilver in the tube of a barometer of about 30 inches in height; it accordingly follows, that the whole pressure of the atmosphere is equal to the weight of a column of quicksilver of an equal base, and 30 inches in height, or the weight of the atmosphere on every square inch of surface is equal to 15 pounds. It has moreover been found, that the pressure of the atmosphere balances, in the case of pumps, &c. a column of water 34½ feet high; and the cubical foot of water weighing just 1000 ounces, or 62½ pounds, 34½ multiplied by 62½ or 2158 *lb.* will be the weight of a column of water, or of the atmosphere on the base of a square foot; and consequently the 144th part of this, or 15 *lb.* is the weight of the atmosphere on a square inch. From these data, Mr. Cotes computed the pressure of the atmosphere on the whole surface of the earth to be equivalent to that of a globe of lead sixty miles in diameter. Dr. Vince and others have given the weight at 77670297973563429 tons. This weight is however variable; it sometimes being much greater than at others. If the surface of a man, for instance, be equal to 14½ square feet, the pressure upon him, when the atmosphere is in its lightest state, is equal to 13½ tons, and when in the heaviest, it is about 14 tons and one-third; the difference of which is about 2464 *lb.* It is surprising that such weights should be able to be borne without crushing the human frame: this indeed must be the case, if all the parts of our body were not endowed with some elastic spring, whether of air or other fluid, sufficient to counterbalance the weight of the atmosphere. Whatever this spring is, it is certain that it is just able to counteract the weight of the atmosphere, and no more; of course it must alter in its force as the density of the atmosphere varies; for if any considerable pressure be superadded to that of the air, as by going into deep water, it is always severely felt; and if, on the other hand, the pressure of the atmosphere be taken off from any part of the human body, by means of the apparatus belonging to the air pump, the inconvenience is immediately perceived.

The difference in the weight of the atmosphere is very considerable, as has been observed, from the natural changes in the state of the air. These changes take place chiefly in countries at a distance from the equator. In Great Britain, for instance, the barometer varies from 28.4 to 30.7. On the increase of this natural weight, the weather is commonly clear and fine, and we feel ourselves alert and active; but when the weight of the air diminishes, the weather is often bad, and we feel listlessness and inactivity. Hence invalids suffer in their health from very sudden changes in the atmosphere. In our observations on the barometer, we have known the mercury to vary a full inch, or even something more, in the course of a few hours. Such changes, however, are by no means frequent. Ascending to the tops of mountains, where the pressure of the air is very much diminished, the inconvenience is rarely felt, on account of the gradual change; but when a person ascends in a balloon with great rapidity, he feels, we are told by Garnerin and other aeronauts, a difficulty of breathing, and many unpleasant sensations. So also on the condensation of the air, we feel little or no alteration in ourselves, except when the variations are sudden in the state of the atmosphere, or by those who descend to great depths in a diving-bell. See DIVING-BELL.

It is not easy to assign the true reason for the changes that happen in the gravity of the atmosphere in the same place. One cause is, undoubtedly, the heat of the sun; for where this is uniform, the changes are small and regular. Thus, between the tropics the barometer constantly sinks about half an inch every day, and rises to its former station in the night. But in the temperate zones, the altitude of the mercury is subject to much more considerable variations, as we have seen with respect to what is observable in our own country.

As to the alteration of heat and cold, Dr. Darwin infers that there is good reason to conclude, that in all circumstances where air is mechanically expanded, it becomes capable of attracting the fluid matter of heat from other bodies in contact with it. Now, as the vast region of air which surrounds our globe is perpetually moving along its surface, climbing up the sides of mountains, and descending into the valleys, as it passes along, it must be perpetually varying the degree of heat according to the elevation of the country it traverses; for, in rising to the summits of mountains it becomes expanded, having so much of the pressure of the superincumbent atmosphere taken away; and when thus expanded, it attracts or absorbs heat from the mountains in contiguity with it; and, when it descends into the valleys, and is compressed into less compass, it again gives out the heat it has acquired to the bodies it comes in contact with. The same thing must happen in the higher regions of the atmosphere, which are regions of perpetual frost, as has lately been discovered by the aerial navigators. When large districts of air, from the lower parts of the atmosphere, are raised two or three miles high, they become so much expanded by the great diminution of the pressure over them, and thence become so cold, that hail or snow is produced by the precipitation of the vapour: and as there is, in these high regions of the atmosphere, nothing else for the expanded air to acquire heat from after it has parted with its vapour, the same degree of cold continues till the air, on descending to the earth, acquires its former state of condensation and of warmth. The Andes, almost under the line, rests its base on burning sands: about its middle height is a most pleasant and temperate climate, covering an extensive plain, on which is built the city of Quito; while its forehead is encircled with eternal snow, perhaps coeval with the mountain. Yet, according to the account of Don Ulloa, these three discordant climates seldom encroach much on each other's territories. The hot winds below, if they ascend, become cooled by their expansion; and hence they cannot affect the snow upon the summit; and the cold winds that sweep the summit, become condensed as they descend, and of temperate warmth before they reach the fertile plains of Quito.

Various attempts have been made to ascertain the height to which the atmosphere is extended all round the earth. These commenced soon after it was discovered, by means of the Torricellian tube, that air is endued with weight and pressure. And had not the air an elastic power, but were it every where of the same density, from the surface of the earth to the extreme limit of the atmosphere, like water, which is equally dense at all depths, it would be a very easy matter to determine its height, from its density, and the column of mercury which it would counterbalance in the barometer tube; for, it having been observed that the weight of the atmosphere is equivalent to a column of 30 inches, or 2½ feet of quicksilver, and the density of the former to that of the latter as 1 to 11040: therefore the height of the uniform atmosphere would be 11040 times 2½ feet, that is 27600 feet, or little more than five miles and a quarter. But the air, by its elastic quality, expands and contracts; and it being found, by repeated experiments in most nations of Europe, that the spaces it occupies, when compressed by different weights, are reciprocally proportional to those weights themselves; or, that the more the air is pressed, so much the less space it takes up; it follows, that the air in the upper regions of the atmosphere must grow continually more and more rare, as it ascends higher; and indeed that, according to that law, it must necessarily be extended to an indefinite height. Now, if we suppose the height of the whole divided into innumerable equal parts, the quantity of each part will be as its density; and the weight of the whole incumbent atmosphere being also as its density; it follows, that the weight of the incumbent air is every where as the quantity contained in the subjacent part; which causes a difference between the weights of each two contiguous parts of air. But, by a theorem in arithmetic, when a magnitude is continually diminished by the like part of itself, and the remainders the same, there will be a series of continued quantities, decreasing in geometrical progression: therefore, if, according to the supposition, the altitude of the air, by the addition of new parts into which it is divided, do continually increase in arithmetical progression, its density will be diminished, or, which is the same thing, its gravity decreased, in continued geometrical proportion. And hence, again, it appears that, according to the hypothesis of the density being always proportional to the compressing force, the height of the atmosphere must necessarily be extended indefinitely. And, farther, as an arithmetical series adapted to a geometrical one is analogous to the logarithms of the said geometrical one; it follows, therefore, that the altitudes are proportional to the logarithms of the densities, or weights of air: and that any height taken from the earth's surface, which is the difference of two altitudes to the top of the atmosphere, is proportional to the difference of the logarithms of the two densities there, or to the logarithm of the ratio of those densities, or their corresponding compressing forces, as measured by the two heights of the barometer there.

It is now easy, from the foregoing property, and two or three experiments, or barometrical observations, made at known altitudes, to deduce a general rule to determine the absolute height answering to any density, or the density answering to any given altitude above the earth. And, accordingly, calculations were made upon this plan by many philosophers, particularly by the French; but it having been found that the barometrical observations did not correspond with the altitudes as measured in a geometrical manner, it was suspected that the upper parts of the atmospherical regions were not subject to the same laws with the lower ones, in regard to the density and elasticity. And indeed, when it is considered that the atmosphere is a heterogeneous mass of particles of all sorts of matter, some elastic, and others not, it is not improbable but this may be the case, at least in the regions very high in the atmosphere, which it is likely may more copiously abound with the electrical fluid. Be this however as it may, it has been discovered that the law above given holds very well, for all such altitudes as are within our reach, or as far as to the tops of the highest mountains on the earth, when a correction is made for the difference of the heat or temperature of the air only, as was fully evinced by M. De Luc, in a long series of observations, in which he determined the altitudes of hills, both by the barometer, and by geometrical measurement, from which he deduced a practical rule to allow for the difference of temperature. Similar rules have also been deduced, from accurate experiments, by Sir George Shuckburgh, and General Roy, both concurring to shew, that such a rule for the altitudes and densities holds true for all heights that are accessible to us, when the elasticity of the air is corrected on account of its density: and the result of their experiments shewed, that the difference of the logarithms of the heights of the mercury in the barometer, at two stations, when multiplied by 10000, is equal to the altitude, in English fathoms, of the one place above the other; that is, when the temperature of the air is about 31 or 32 degrees of Fahrenheit's thermometer, and a certain quantity more or less, according as the actual temperature is different from that degree.

But it may be shewn, that the same rule may be deduced, independent of such a train of experiments as those referred to, merely by the density of the air at the surface of the earth. Thus, let D denote the density of the air at one place, and d the density at the other; both measured by the column of mercury in the barometrical tube; then the difference of altitude between the two places will be proportional to the log. of D — the log. of d, or to the log. of $\frac{D}{d}$. But as this formula expresses only the relation between different altitudes, and not the absolute quantity of them, assume some indeterminate, but constant quantity h, which multiplying the expression log. $\frac{D}{d}$, may be equal to the real difference of altitude a, that is, $a = h \times \text{log. of } \frac{D}{d}$. Then, to determine the value of the general quantity h, let us take a case in which we know the altitude a that corresponds to a known density d; as for instance, taking $a = 1$ foot, or 1 inch, or some such small altitude: then, because the density D may be measured by the pressure of the whole atmosphere, or the uniform column of 27600 feet, when the temperature is 55°; therefore 27600 feet will denote the density D at the lower place, and 27599 the less density d at 1 foot above it; consequently $1 = h \times \text{log. of } \frac{27600}{27599}$, which by the nature of logarithms, is nearly $= h \times \frac{.43429448}{27600}$ or $\frac{1}{63551}$ nearly; and hence we find $h = 63551$ feet; which gives us this formula for any altitude a in general, viz. $a = 63551 \times \text{log. of } \frac{D}{d}$, or $a = 63551 \times \text{log. of } \frac{M}{m}$ feet, or $10592 \times \text{log. of } \frac{M}{m}$ fathoms; where M denotes the column of mercury in the tube at the lower place, and m that at the upper. This formula is adapted to the mean temperature of the air 55°: but it has been found, by the experiments of Sir George Shuckburgh and General Roy, that for every degree of the thermometer, different from 55°, the altitude a will vary by its 435th part; hence, if we would change the factor h from 10592 to 10000, because the difference 592 is the 18th part of the whole factor 10592, and because 18 is the 24th part of 435; therefore the change of temperature, answering to the change of the factor h, is 24°, which reduces the 55° to 31°. So that, $a = 10000 \times \text{log. of } \frac{M}{m}$ fathoms, is the easiest expression for the altitude, and answers to the temperature of 31°, or very nearly the freezing point: and for every degree above that, the result must be increased by so many times its 435th part, and diminished when below it.

From this theorem it follows, that, at the height of 3½ miles, the density of the atmosphere is nearly 2 times rarer than it is at the surface of the earth; at the height of 7 miles, 4 times rarer; and so on, according to the following table:

Height in miles.	Number of times rarer.
3½	2
7	4
14	16
21	64
28	256
35	1024
42	4096
49	16384
56	65536
63	262144
70	1048576

And, by pursuing the calculations in this table, it might be easily shewn, that a cubic inch of the air we breathe would be so much rarefied at the height of 500 miles, that it would fill a sphere equal in diameter to the orbit of Saturn.

It has been observed above, that the asmosphere has a refractive power, by which the rays of light are bent from the right lined direction, as in the case of the twilight; and many other experiments manifest the same virtue, which is the cause of many phenomena. Alhazen, the Arabian, who lived about the year 1100, it seems, was more inquisitive into the nature of refraction than former writers. But neither Alhazen, nor his follower Vitello, knew any thing of its just quantity, which was not known, to any tolerable degree of exactness, till Tycho Brahe, with great diligence, settled it. But neither did Tycho nor Kepler discover in what manner the rays of light were refracted by the atmosphere. Tycho thought the refraction was chiefly caused by dense vapours, very near the earth's surface: while Kepler placed the cause wholly at the top of the atmosphere, which he thought was uniformly dense; and thence he determined its altitude to be little more than that of the highest mountains. But the true constitution of the density of the atmosphere, deduced afterwards from the Torricellian experiment, afforded a juster idea of these refractions, especially after it was found, that the refractive power of the air is proportional to its density. By this variation in the density and refractive power of the air, a ray of light, in passing through the atmosphere, is continually refracted at every point, and thereby made to describe a curve, and not a straight line, as it would have done, were there no atmosphere, or were its density uniform.

The atmosphere, or air, has also a reflective power; and this power is the means by which objects are enlightened so uniformly on all sides. The want of this power would occasion a strange alteration in the appearance of things, the shadows of which would be so very dark, and their sides enlightened by the sun so very bright, that probably we could see no more of them than their bright halves; so that for a view of the other halves, we must turn them half round, or if immoveable, must wait till the sun could come round upon them. Such a pellucid unreflective atmosphere would indeed have been very commodious for astronomical observations on the course of the sun and planets among the fixed stars, visible by day as well as by night; but then such a sudden transition from darkness to light, and from light to darkness, immediately upon the rising and setting of the sun, without any twilight, and even upon turning to or from the sun at noon day, would have been very inconvenient and offensive to our eyes. However, though the atmosphere be greatly assistant in the illumination of objects, yet it must also be observed that it stops a great deal of light.

The knowledge of the component parts of the atmosphere is among the discoveries of the moderns. The opinions of the earlier chemists were too vague to merit any particular notice. Boyle, however, and his contemporaries, put it beyond doubt, that the atmosphere contained two distinct substances, *viz.* an elastic fluid, distinguished by the name of air, and water in the state of vapour. Besides these two bodies, it was supposed that the atmosphere contained a great variety of other substances, which were continually mixing with it from the earth, and which often altered its properties, and rendered it noxious or fatal. Since the discovery of carbonic acid gas by Dr. Black, it has been ascertained that this elastic fluid always constitutes a part of the atmosphere. The constituent parts of the atmosphere are, according to Mr. Murray,

	By measure.	By weight.
Nitrogen gas	77.5	75.55
Oxygen gas	21.0	23.32
Aqueous vapour	1.42	1.03
Carbonic acid gas	.08	.10
	100.00	100.00

It has been imagined that a portion of hydrogen may exist in the atmospheric air. But in the usual analysis of it oxygen is abstracted, and the residual air is found to be nitrogen. The nitrogen is probably not perfectly pure, and it is possible a small portion of hydrogen is mixed with it, which, from the quantity being very trifling, is difficult to be detected.

The properties of atmospheric air appear to be merely the aggregated properties of the gases of which it consists. It is invisible, inodorous, insipid, compressible, and permanently elastic. It supports combustion, and as it does so from the oxygen it contains, the combustion is less rapid and vivid, and continues for a shorter time. By the same agency it supports animal life; a portion of its oxygen is consumed in respiration, and from some experiments of Mr. Davy, there appears to be a consumption of a very small portion of its nitrogen. Atmospheric air is very sparingly absorbed by water; and the absorption is unequal, more of the oxygen being combined with the water than of the nitrogen. It is difficult, even by long boiling, to expel from water the whole of the oxygen which it holds dissolved; and, if exposed again to the atmosphere, it very quickly imbibes it.

Atmospheric air is an important agent in many of the operations of nature. Besides serving as the vehicle of the distribution of water, it is, by its mobility, the great agent by which temperature is in some measure equalized, or at least its extremes moderated. Animals, as we have seen, are dependent on it for life. It is essential to respiration; in the more perfect animals, its deprivation cannot be sustained for a few moments; and even in the less perfect, the abstraction of it is followed, though not so immediately, by death. Its agency depends chiefly on its oxygen, a quantity of which is spent in every inspiration in producing chemical changes in the blood. A part of its nitrogen also is consumed, while a portion of carbonic acid gas is formed and expired. Vegetable life is also in part dependent on it; it conveys water and perhaps carbonic acid gas, and other principles, to the leaves of plants, and is thus subservient to their nutrition and growth.

ATOMICAL *philosophy* denotes the doctrine of atoms, or a method of accounting for the origin and formation of all things from the supposition of atoms endued with gravity and motion. The atomic phisiology, according to the account given of it by Dr. Cudworth, supposes that body is nothing else but an extended bulk; and resolves, therefore, that nothing is to be attributed to it but what is included in the nature and idea of it, *viz.* more or less magnitude, with divisibility into parts, figure, and position, together with motion or rest; but so as that no part of body can ever move itself, but is always moved by something else. And consequently it supposes that there is no need of any thing else besides the simple elements of magnitude, figure, site, and motion, which are all clearly intelligible, as different modes of extended substance to solve the corporeal phenomena by; and, therefore, not of any substantial forms distinct from the matter, nor of any other qualities really existing in the bodies without, besides the results or aggregates of those simple elements, and the disposition of the insensible parts of bodies, in respect of figure, site, and motion, nor of any intentional species or shews, propagated from the object to our senses; nor, lastly, of any other kind of motion or action really distinct from local motion, such as generation and alteration, they being neither intelligible as modes of extended substance, nor any ways necessary. Forasmuch as the forms and qualities of bodies may well be conceived to be nothing but the result of those simple elements of magnitude, figure, site, and motion, variously combined together, in the same manner as syllables and words, in great variety, result from the different combinations and conjunctions of a few letters, or the simple elements of speech; and the corporeal part of sensation, particularly that of vision, may be solved only by local motion of bodies, that is, either by corporeal effluvia streaming continually from the surface of the objects, or rather, as the later and more refined atomists conceived, by pressure made from the object to the eye, by means of light in the medium. So that the sense taking cognizance of the object by the subtle interposed medium, that is tense and stretched, (thrusting every way from it upon the optic nerves) doth by that, as it were by a staff, touch it. Again, generation and corruption may be sufficiently explained by concretion and secretion, or local motion, without substantial forms and qualities. And, lastly, those sensible ideas of light and colours, heat and cold, sweet and bitter, as they are distinct things from the figure, site, and motion of the insensible parts of bodies, seem plainly to be nothing else but our own fancies, passions, and sensations, however they be vulgarly mistaken for qualities in the bodies without us.

ATRA *bilis*, in ancient medicine, the black bile, one of the humours of the ancient physicians, which the moderns call melancholy. Dr. Percival suggests that this disorder is occasioned by the stagnation of the gall, by which it is rendered too viscid by the absorption of its fluid parts. Bile in this state discharged into the duodenum occasions universal disturbance until it be evacuated. It brings on vomiting, purging, &c. previous to which are fever, delirium, &c.

ATRACTYLIS, in botany, a genus of the Syngenesia Polygamia class of plants, with radiated flowers and compressed seeds, coronated with a plumose down, and standing on a plane villose receptacle. There are eight species, of which we may notice the A. gummifera, gummy-rooted atractylis; root perennial, sending out many narrow leaves, which are deeply sinuated, and armed with spines on the edges; these lie close on the ground, and between them the flower is situated; it is a native of Italy and the islands of the Archipelago. It flowers in July, but the seeds never come to perfection in England.

ATRAGENE, in botany, a genus of the Polyandria Pologynia class of plants, the flower of which consists of twelve petals, and its seeds are caudated. There are five species. This genus is allied to Ranunculus, but has a double row of petals; in the outer row four large ones, in the inner many small ones, which are properly nectaries. The A. alpina may be increased by cuttings or layers in the same manner as clematis; in a strong soil, and trained against a wall, it will rise to the height of six or eight feet. The flowers appear early, and if the season prove favourable, they make a handsome figure; but as this plant is apt to put out leaves very early in the spring, it is frequently nipped by the frosts; as are many plants and trees of Siberia and Tartary, of which this is a native. There is only one American species, the Atragena Pennsylvanica.

ATAPHRAXIS, in botany, a genus of the Hexandria Digynia class of plants, the flower of which consists of two roundish, sinuated and permanent petals; and its cup incloses a single, roundish and compressed seed. There are two species; 1. the spinosa, a shrub that rises four or five feet high, sending out many weak lateral branches, armed with spines, and garnished with small ash-coloured leaves. The flowers come out at the end of the shoots in clusters, each consisting of two white petals tinged with purple, included in a two-leaved calyx, of a white herbaceous colour. 2. A. undulata, which sends out many slender branches trailing on the ground; leaves about the size of those of knot-grass, waved and curled on their edges, embracing the stalk half round at their base. This is a native of the Cape.

ATRIPLEX, *orach*, in botany, a genus of the Polygamia Monoecia class of plants, without any flower petals; the cup of the female flower is composed of two leaves, inclosing a single and compressed seed; whereas that of the hermaphrodite flower is composed of five leaves, and encloses a single, roundish, and depressed seed. There are 14 species. The American species, enumerated by Muhlenberg, are 5 in number.

ATROPA, in botany, a genus of the Pentandria Monogynia class of plants, the flower of which consists of a single funnel-fashioned petal; the fruit is a globose berry, containing two cells, wherein the seeds inclosed are numerous and kidney-shaped.

There are eight species, of which we notice, in this place, the A. belladonna, deadly night-shade, which has a perennial, thick, long, and branching root, sending out strong, herbaceous, upright, branching stems; the root-leaves are often a foot long, and five inches broad; peduncles axillary, one-flowered; flowers, large, nodding, void of scent; calyx green; berry large, at first green, but when ripe of a beautiful shining black colour, full of purple juice; with roundish, dotted, channelled seeds, immersed in the pulp, and a glandular ring surrounding it. It is a native of Europe, particularly of Austria and England, in church yards and on dunghills, skulking in gloomy lanes and uncultivated places; in other countries it is said to be common in woods and hedges. The qualities of this plant are malignant, and it is extremely poisonous in all its parts. Numerous instances have occurred of the berries proving fatal, after causing convulsions and delirium. Buchanan relates the destruction of the army of Sweno the Dane, when he invaded Scotland, by the berries of this plant, which were mixed with the drink with which the Scots had engaged to supply the Danes. The invaders became so inebriated, that the Scottish army fell on them in their sleep, and slew such numbers, that scarcely enough were left to carry off their king. To children the berries have often been fatal. The symptoms occur in half an hour, and consist of vertigo, great thirst, delirium, swelling, and redness of face. Vinegar liberally drank has been found efficacious in obviating the effects of the poison. There is one American species, Atropa physatoides. See MANDRAKE.

ATROPHY, in medicine, a disease wherein the body, or some of its parts, do not receive the necessary nutriment, but waste and decay incessantly. See MEDICINE.

ATTACHING, or ATTACHMENT, in law, the taking or apprehending of a person by virtue of a writ or precept.

It is distinguished from an arrest in this respect, that whereas an arrest lies only on the body of a man, an attachment is oftentimes on the goods only, and sometimes on the body and goods; there is this farther difference, that arrest proceeds out of an inferior court by precept only, and an attachment out of a higher court, either by precept or writ.

An attachment by writ differs from distress, insomuch that an attachment does not extend to lands, as a distress does; and a distress does not touch the body, as an attachment does.

In the common acceptation, an attachment is the apprehension of a man's body, to bring him to answer the action of the plaintiff.

Attachment *out of the chancery* is obtained upon an affidavit made, that the defendant was served with a subpœna, and made no appearance; or it issueth upon not performing some order or decree. Upon the return of this attachment by the sheriff, *quod non est inventus in balliva sua*, another attachment, with a proclamation, issues; and if he appears not thereupon, a commission of rebellion.

Attachment *out of the forest*, is one of the three courts held in the forest. The lowest court is called the court of attachment, or wood-mote court: the mean, swan-mote; and the highest, the justice in the eyre's seat.

This attachment is by three means, by goods and chattels, by body, pledges, and mainprize, or the body only. This court is held every forty days throughout the year, whence it is called forty-days court.

Attachment *of privilege*, is by virtue of a man's privilege to call another to that court whereto he himself belongs, and in respect whereof he is privileged to answer some action.

Attachment, *foreign*, is an attachment of money or goods, found within a liberty or city, to satisfy some creditor within such liberty or city.

By the custom of London and several other places, a man can attach money or goods in the hands of a stranger to satisfy himself.

ATTAINDER, in law, is when a man has committed felony or treason, and sentence is passed upon him for the same. The children of a person attainted of treason are, thereby, rendered incapable of being heirs to him, or to any other ancestor; and if he were noble before, his posterity are degraded and made base: nor can this corruption of blood be salved but by an act of parliament, unless the sentence be reversed by a writ of error.

Attainder, *bill of*, a bill brought into parliament, for attainting, condemning, and executing a person for high-treason.

ATTAINT, in law, a writ which lies against a jury that have given a false verdict in any court of record, in a real or personal action, where the debt or damages amount to above forty shillings.

If the verdict be found false, the judgment by common law was, that the jurors' meadows should be ploughed up, their houses broken down, their woods grubbed up, all their lands and tenements forfeited, &c. but by statute the severity of the common law is mitigated, where a petty jury is attainted, and there is a pecuniary penalty appointed.

But if the verdict be affirmed, such plaintiff shall be imprisoned and fined.

ATTELABUS, in natural history, a genus of insects of the order Coleoptera. Head attenuated behind; antennæ thickening towards the tip; moniliform.

Of the genus Attelabus one of the principal species is the Attelabus, coryli of Linnæus, which is a smallish insect, found chiefly on hazel trees, and is black, with red wing-sheaths; and a variety sometimes occurs, in which the thorax is red also; it usually measures about a quarter of an inch in length. A much smaller species is the Attelabus betulæ, which is found on the birch; it is entirely of a black colour, and is remarkable for gnawing the leaves of that tree, during the early part of spring, in such a manner that they appear notched on the edges. The thighs of the hind legs in this insect are of a remarkable thickened form. The larvæ of the attelabi do not seem to have been distinctly described, but they probably bear a resemblance to those of the genus Curculio. Linnæus refers to the genus attelabus some insects, which by later entomologists have been otherwise arranged: among these is the elegant species called Attelabus apiarius, so named from the mischief which its larva occasionally commits among bee-hives, destroying the young of those insects. It is about three-quarters of an inch in length, and of a beautiful violet black, with red wing-shells, marked by three black transverse bands. The whole insect is also covered with fine short black hair. It is common in some parts of France, Germany, &c. Its larva above mentioned is of a bright red colour. There are 13 species.

ATTENDANT, in law, one that owes duty or service to another, or in some manner depends upon him, as a widow endowed of lands by a guardian shall be attendant upon him.

ATTESTATION, in military affairs, is a certificate made by some justice of the peace, within four days after the enlistment of a recruit. This certificate is to bear testimony, that the said recruit has been brought before him in conformity to the mutiny act, and has declared his assent or dissent to such enlistment; and if duly enlisted, that the proper oaths have been administered, and that the 2nd and 6th sections of the articles of war against desertion have been read to him.

ATTITUDE, in painting and sculpture, the gesture of a figure, or statue; or it is such a disposition of their parts, as serves to express the action and sentiments of the person represented.

ATTORNEY *general*, is a great officer under the king, created by letters patent, whose office it is to exhibit informations, and prosecute for the crown in criminal causes, and to file the bills in the exchequer, for any thing concerning the king in inheritance or profits. To him come warrants for making of grants, pardons, &c.

ATTORNIES *at law*, are such persons as take upon them the business of other men, by whom they are retained. By the 2 Geo. II. cap. 23, s. 5, no person shall be permitted to act as an attorney, or to sue out any process in the name of any other person, in any courts of law, unless such person shall have been bound by contract in writing, to serve as a clerk for five years to an attorney, duly sworn and admitted in some of the said courts; and such person, during the said term of five years, shall have continued in such service, and unless such person, after the expiration of the said five years, shall be examined, sworn, admitted, and inrolled. And for every piece of vellum, parchment, or paper, upon which shall be written any such contract, whereby any person shall become bound to serve as a clerk aforesaid, in order to his admission as solicitor or attorney, in any of the courts at Westminster, there shall be charged a stamp duty of 100*l.* 34. Geo. III. c. 14. And in order to his admission as a solicitor or attorney in any of the great courts of sessions in Wales, or in the counties palatine of Chester, Lancaster, or Durham, or in any court of record in England, holding pleas to the amount of 40 shillings, and not in any of the said courts in Westminster, there shall be charged a stamp duty of 50*l.* Every attorney, solicitor, notary, proctor, agent, or procurator, practising in any of the courts at Westminster, ecclesiastical, admiralty, or Cinque-port courts, in his Majesty's courts in Scotland, the great sessions in Wales, the courts in the counties Palatine, or any other courts holding pleas to the amount of 40 shillings, or more, shall take out a certificate annually, upon which there shall be charged, if the solicitor, &c. reside within the bills of mortality, a stamp-duty of 5*l.* in any other part of Great Britain 3*l.* Persons practising after the 1st day of November, 1797, without obtaining a certificate, shall forfeit 50*l.* and be incapable of suing for any fees. An attorney shall not be elected into any office against his will, such as constable, overseer of the poor, or churchwarden, or any office within a borough: but his privilege will not exempt him from serving in the militia, or finding a substitute. Black. Rep. 1123.

ATTRACTION, a general term, used to denote the power or principle by which bodies mutually tend towards each other, without regarding the cause or action that may be the means of producing the effect.

The philosopher Anaxagoras, who lived about 500 years before the Christian æra, is generally considered as the first who noticed this principle, as subsisting between the heavenly bodies and the earth, which he considered as the centre of their motions. The doctrines of Epicurus and of Democritus are founded on the same opinion.

Nicholas Copernicus appears to have been one of the first among the moderns, who had just notions of this doctrine.

After him, Kepler brought it still nearer perfection, having determined that bodies tended to the centres of the larger round bodies, of which they formed a part, and the smaller celestial bodies to the great ones nearest to them, instead of to the centre of the universe: he also accounted for the general motion of the tides on the same principle, by the attraction of the moon; and expressly calls it *virtus tractoria quæ in luna est;* besides this, he refuted the old doctrine of the schools, "that some bodies were naturally light, and for that reason ascended, while others were by their nature heavy, and so fell to the ground: declaring that no bodies whatsoever are absolutely light, but only relatively so, and that all matter is subjected to the law of gravitation.

Dr. Gilbert, a physician at London, was the first in this country who adopted the doctrine of attraction; in the year 1600, he published a work, entitled "De Magnete Magneticisque Corporibus;" which contains a number of curious things; but he did not sufficiently distinguish between attraction and magnetism.

The next after him was Lord Bacon, who, though not a convert to the Copernican system, yet acknowledged an attractive power in matter.

In France, also, we find Ferinat and Roberval, mathematicians of great eminence, maintaining the same opinion. The latter, in particular, made it the fundamental principle of his system of physical astronomy, which he published in 1644, under the title of "Arist. Samii de Mundi Systema."

Dr. Hooke, however, was the person who conceived the most just and clear notions of the doctrine of gravitation, of any before Newton, in his work, called "An Attempt to prove the Motion of the Earth:" 1674. He observes, that the hypothesis on which he explains the system of the world, is in many respects different from all others; and that it is founded on the following principles: 1. That all the heavenly bodies have not only an attraction or gravitation towards their own centres, but that they mutually attract each other within the sphere of their activity. 2. That all bodies which have a simple or direct motion continue to move in a right line, if some force operating without incessantly, does not constrain them to describe a circle, an ellipse, or some other more complicated curve. 3. That attraction is so much the more powerful, as the attracting bodies are nearer to each other.

But the precise determination of the laws and limits of the doctrine of attraction, was reserved for the genius of Newton: in the year 1666, he first began to turn his attention to this subject, when, to avoid the plague, he had retired from London into the country; but, on account of the incorrectness of the measures of the terrestrial meridian, made before this period, he was unable to bring his calculations on the subject to perfection at first.

Some years afterwards, his attention was again called to attraction by a letter of Dr. Hooke's; and Picard, having about this time measured a degree of the earth, in France, with great exactness, he employed this measure in his calculations, instead of the one he had before used, and found, by that means, that the moon is retained in her orbit by the sole power of gravity, supposed to be reciprocally proportional to the squares of the distances.

According to this law, he also found, that the line described by bodies in their descent is an ellipse, of which the centre of the earth occupies one of the foci; and considering afterwards, that the orbits of the planets are in like manner ellipses, having the centre of the sun in one of their foci, he had the satisfaction to perceive, that the solution which he had undertaken only from curiosity, was applicable to some of the most sublime objects in nature. These discoveries gave birth to his celebrated work, which has justly immortalized his name, entitled "Philosophicæ Naturalis Principia Mathematica."

In generalising these researches, he shewed that a projectile may describe any conic section whatsoever, by virtue of a force directed towards its focus, and acting in proportion to the reciprocal squares of the distances. He also developed the various properties of motion in these kinds of curves, and determined the necessary conditions, so that the section should be a circle, an ellipse, or an hyperbola, which depend only upon the velocity and primitive position of the body, assigning in each case the conic section which the body would describe.

He also applied these researches to the motion of the satellites and comets, shewing that the former move round their primaries, and the latter round the sun, according to the same law; and he pointed out the means of determining by observation the elements of these ellipses.

He also discovered the gravitation of the satellites towards the sun, as well as towards the planets; and that the sun gravitates towards the planets and satellites, as well as that these gravitate towards each other: and afterwards extending, by analogy, this property to all bodies, he established the principle, that every molecule of matter attracts every body in proportion to its mass, and reciprocally as the square of the distance from the body attracted.

Having ascertained this principle, he from it determined, that the attractive force of a body on a point placed without it is the same as if the whole mass were united at the centre. He also proved, that the rotation of the earth upon its axis must occasion a flattening of it about the poles; which has since been verified by actual measurement: and determined the law of the variation of the degrees in different latitudes, upon the supposition that the matter of the earth was homogeneous.

But, with the exception of what concerns the elliptical motions of the planets and comets, and the attractions of the heavenly bodies, these discoveries were not wholly completed by Newton. His theory of the figures of the planets is limited by the supposition of their homogeneity; and his solution of the problem of the precession of the equinoxes is defective in several respects. He has perfectly established the principle which he had discovered; but left the complete development of its consequences to the geometers that should succeed him.

The profound analysis also, of which he was the inventor, had not been sufficiently perfected, to enable him to give complete solutions to all the difficult problems which arise, in considering the theory of the system of the world; so that he was oftentimes obliged to give only imperfect sketches or approximations, and leave them to be verified by a more rigorous calculation.

Attraction may be divided, with respect to the law it observes, into two kinds. 1. That which extends to sensible distances, such is the attraction of gravity, of which we have been treating, which is found in all bodies, and the attraction of magnetism and of electricity found in some particular bodies; 2. That which extends to very small, or insensible distances.

The attractions belonging to the first class must be as numerous as there are bodies situated at sensible distances. It has been proved that their intensity varies with the mass and the distance of the attracting bodies; it increases with the mass of those bodies, but diminishes as the distance between them increases. The rate of variation has been demonstrated to be inversely as the square of the distance, in all cases of attraction belonging to the first class.

The nature of the attraction of gravity has been already discussed. It is, as far as the experience of man can extend, universal in all matter. The attractions of magnetism and of electricity are partial, being confined to certain sets of bodies, while the rest of matter is destitute of them; for it is well known that all bodies are not electric, and that scarcely any bodies are magnetic, except iron, cobalt, nickel, and chromium; and there is good reason to suspect that the magnetism of the three latter substances is caused by their containing some iron united to them.

The intensity of these three attractions increases as the mass of the attracting bodies, and diminishes as the square of the distance.

The first extends to the greatest distance at which bodies are known to be separated from each other. How far electricity extends has not been ascertained; but magnetism extends at least so far as the semidiameter of the earth. All bodies possess gravity; but it has been supposed that the other two attractions are confined to two or three subtile fluids, which constitute a part of all those bodies that exhibit the attractions of magnetism or of electricity.

If we compare the different bodies acted on by gravitation, we shall find that the absolute force of their gravitation is in all cases the same, provided their distances from each other, and their mass, be the same; but this is by no means the case with electrical and magnetic bodies: in them, the forces by which they are attracted towards each other are exceedingly various, even when the mass and the distance are the same. Sometimes these forces disappear almost entirely; at other times they are exceedingly intense.

Gravity, therefore, is a force inherent in bodies; electricity and magnetism not so; a circumstance which renders the opinion of their depending on peculiar fluids extremely probable. If we compare the absolute force of these three powers with each other, it would appear that the intensity of the two last, every thing else being equal, is greater than that of the first; but their relative intensity cannot be compared, and is therefore unknown. Hence it follows that these different attractions, though they follow the same laws of variation, are not the same in kind.

The attractions between bodies at insensible distances have been distinguished by the name of affinity, while the term attraction has been more commonly confined to cases of sensible distance.

Affinity may be considered as operating on homogeneous or heterogeneous substances. Homogeneous affinity urges substances of the same nature together, as iron to iron, soda to soda. Heterogeneous affinity draws substances of different natures into union, as acid and alkalies.

Homogeneous affinity is usually denominated cohesion, and sometimes adhesion, when the surfaces of bodies are only referred to; it is nearly universal; as far as is known, caloric and light alone are destitute of it.

Heterogeneous affinity is the cause of the formation of compound substances; thus muriatic acid unites with soda, and forms sea-salt; and sea-salt in saturated solution is united into masses by homogeneous affinity. Heterogeneous affinity is universal, as far as is known; that is to say, there is no substance which is not attracted by some other substance. It is generally taken for granted, that every substance has more or less affinity for all others, though it is certainly assuming more than even analogy can warrant, and is a point which we have no means of ascertaining.

Affinity, like sensible attraction, varies with the mass and the distance of the attracting bodies. That cohesion varies with the mass cannot indeed be ascertained, because we have no means of varying the mass, without at the same time, altering the distance. But in cases of the adhesion of the surfaces of homogeneous bodies, which is undoubtedly an instance of homogeneous affinity, it has been demonstrated that the force of adhesion increases with the surface, which, in some respect, is the same as with the mass.

That heterogeneous affinity increases with the mass has been observed long ago, in particular instances, and has been lately demonstrated by Berthollet to take place in every case. Thus, a given portion of water is retained more obstinately by a large quantity of sulphuric acid, than by a small quantity. Oxygen is more easily abstracted from oxides which are oxydised to a maximum, than from those which are oxyded to a minimum. Lime only takes off the greatest part of the carbonic acid from potash, which still retains a portion of it; and sulphuric acid does not totally displace phosphoric acid from the lime united to it in phosphate of lime; a part of it remains undisturbed. In these, and many other cases, a small portion of one substance is retained by a given quantity of another more strongly than a large portion; and Berthollet has shewn, that in all cases a large quantity of one substance is capable of abstracting a portion of another from a small portion of a third, how weak soever the affinity between the first and second is, and how strong soever that between the second and third.

That the force of affinity increases as the distance diminishes, and the contrary, is obvious; for it becomes insensible, whenever the distance is sensible, and, on the other hand, it becomes exceedingly great, when the distance is exceedingly diminished. But the particular rate which this variation follows is still unknown; some have supposed the rate to be the same as that of sensible attraction, and that its intensity varies inversely, as the square of the distance; no sufficient argument has ever been advanced, to prove this law to be incompatible with the phenomena of affinity; but, on the other hand, no proof has ever appeared in support of this opinion.

Affinity agrees with sensible attraction in every determinable point: like sensible attraction, it increases with the mass, and diminishes as the distance augments; consequently, it is just to conclude, that attraction, whether it be sensible or insensible, is, in all cases, the same kind of force, and regulated precisely by the same general laws.

The forces of affinity, though the same in kind, and possessing the same rate of variation with regard to distances, and also in respect to the mass, are vastly more numerous than those of sensible attraction; for, instead of three, they amount to as many as there are heterogeneous bodies. But even when the distance and the mass are the same, as far as can be judged, the affinity of two bodies for the third is not the same. Thus barytes has a stronger affinity for sulphuric acid than potash has; for, on equal portions of them being mixed with a small quantity of the acid, the barytes siezes a much larger proportion of the acid than the potash does. The difference of intensity extends to all substances, for there are scarcely any two bodies, whose particles have precisely the same affinity for a third, and scarcely any two bodies, whose component parts adhere together with exactly the same force.

Because these affinities do not vary in common circumstances, like magnetism and electricity, but are always the same when other circumstances are equal, it has been argued that they do not, like them, depend on peculiar fluids, the quantity of which may vary; but that they are permanent forces, inherent in every part of the attracting bodies.

But after the extraordinary discoveries that have been lately made of the powerful effects which electricity, as excited by the galvanic apparatus, has in chemical attractions, and when the great force of the affinity of the bases of potash and of soda to oxygen have been overcome by it, we must hesitate at least in continuing the above opinion, if we do not totally reject it, to adopt its reverse, and consider electric fire, in future, as the great agent of elective affinities. There is no reason why electric fire may not be subject to the same laws of attraction as other substances, and why it may not remain united to bodies in a latent or inactive state, as well as caloric; we have already shewn, that the mass of any substance has a powerful effect on its degree of affinity; many of the effects of electric fire on affinity might be explained by this increased power of it, when acting in a mass, or at farthest by supposing, that its power increased with its mass in a greater ratio than that of other substances.

It has been judiciously remarked, by a respectable chemical writer, that the variation of intensity, which forms so remarkable a distinction between affinity and gravitation, may be only apparent, and not real, and may only arise from the much nearer approach which the parts of one substance may be capable of, to those of a second, than to those of a third; and that thus it may be that barytes attracts sulphuric acid with greater intensity than potash, because the particles of barytes, when they act upon the acid, are at a smaller distance from it than the particles of the potash; to which we shall add, that it is possible that the degree of insensible distance to which the parts of substances can approach, depends on the quantity of latent electric fire combined with them, or in other words, on the degree of their relative attractions to electric fire.

This conjecture of the agency of electric fire, in elective attractions, has, at least, the advantage of the atomic theory, which has been advanced to account for the same phenomena, that it relates to matters which we know really exist, and which are not, beyond the bounds of hope, indeterminable by experiment. With all due deference to the respectable characters who have used the atomic theory as an universal explainer, we beg leave to remind its admirers, that it is totally inconsistent with the laws of sound philosophy, to assume a fact as the basis of an argument, which itself has never had the shadow of proof to support it, and which in its nature is incapable of experiment. It is idle, in the present respectable state of science, to talk any more of atoms: as well may we again revive the dreams of the ancients about the materia subtilis, or those of Des Cartes, relative to vortices, as to reason of the shape, form, nature, and properties of atoms, which, from their very definition, are merely visionary, and which, the moment we conceive them as having shape, lose their essential quality of indivisibility; if the existence of atoms cannot be disproved, that is no argument in favour of their existence in the way usually supposed; and the atomic theory has only this property, in common with every other which lies beyond the reach of our senses.

Judicial astrology, magic, and many other chimeras, cannot be disproved; but, at least, since the great law of truth has been adopted for philosophy, that no argument was to be admitted in it that was not demonstrable by experiment, or by proof equally satisfactory, mankind has ceased to be led astray by them.

It is now high time either to banish the atomic theory into the same regions of oblivion as the others abovementioned, or to prove the existence of the atoms on which it is founded; but as this is in its nature an impossibility, it is to be hoped that the time is not far distant when philosophers will cease to confound imaginary beings with real existences, and when all that has been written of atoms will be in no more esteem than the voluminous treatises de Pygmies et Salamandris, which are to be found among the folios of some of our great academical libraries.

It is true, that the atomic theory accounts plausibly for many things we otherwise must be content to own are yet beyond our knowledge; this may be a convenience to those who wish to impose on the ignorant; but all true lovers of science will despise so paltry a resource, especially when so much is now known, that we need no longer blush to own those points which are still involved in obscurity, and shew the boundaries, on the map of science, between the regions of knowledge and the terra incognita of visionary theory.

In the above respect of accounting for matters unknown, the ideal system of Bishop Berkley is equally powerful as, if not superior to the atomic theory, and has the advantage over it of turning our thoughts incessantly to the Almighty Author of all things; for which reason, if we must have recourse to improved theories, Berkley's very much deserve the preference.

As to the more minute nature of bodies, we know that all mineral substances are resolvable into small laminæ or spicula, of determinate shapes, which, by their multifarious combinations, produce the variously formed crystals, which all mineral bodies may be resolved into by art, which most may be made to exhibit by skilful dissection, and which so many shew naturally. Vegetable substances are resolvable into small fibres, as are likewise animal substances for the most part; and from the laws of sound philosophy, we must consider the laminæ or spicula, which form the basis of crystallization, as the primary parts of mineral bodies, and fibres as those of organized bodies, until something further can be proved on the subject. These primary parts of bodies adhere together, it is most probable, by the attraction of cohesion, (as do also their combinations into crystals and other forms,) modified in some degree by that attraction caused by electric fire.

The attraction which takes place among substances in solution is not so easily comprehended, as we know nothing as yet of the exact state in which a substance, capable of solidity, exists, when dissolved in a fluid. In our present state of knowledge, we can only consider it as a fluid itself, capable of reassuming a solid form in certain circumstances.

The attraction which takes place between bodies in a state of vapour is similar to that in a fluid state; their precise and minute state in that condition is unknown; but the combinations which ensue from the attractions of many, in both states, are familiar to all chemists, and from them have proceeded many of the most useful substances which we possess. It is very fortunate for us, however, that if the knowledge of the minute and primary state of bodies is, as it were, concealed from our view by an impenetrable veil, it is not of any very great importance to us, as the effects which bodies produce on each other can be known to us without it, and it is this latter species of knowledge that affords us the dominion over nature, supplies our wants, and forms the basis of worldly happiness.

The characteristic marks of affinity may be reduced to the three following:

1. It acts only at insensible distances, and of course affects only the minute parts of bodies.

2. This force is always the same in the same substances; but is different in different substances.

3. This difference is considerably modified by the mass. Thus, though A has a greater affinity for C than B has, if the mass of B be considerably increased, while that of A remains unchanged, B becomes capable of taking a part of C from A.

ATTRIBUTES, in logic, are the predicates of any subject, or what may be affirmed or denied of any thing.

Attributes, in painting and sculpture, are symbols added to several figures, to intimate their particular office and character.

Thus, the eagle is an attribute of Jupiter; a peacock, of Juno; a caduce, of Mercury; a club, of Hercules; and a palm, of Victory.

ATTRITION, the rubbing or striking of bodies one against another, so as to throw off some of their superficial particles.

The grinding or polishing of bodies is performed by attrition, the effects of which are, heat, light, fire, and electricity.

Attrition is also often used for the friction of such simple bodies, as do not wear from rubbing against one another, but whose fluids are, by that motion, subjected to some particular determination; as the various sensations of hunger, pain, and pleasure, are said to be occasioned by the attrition of the organs formed for such impressions.

AVALANCHES, a name given in Swisserland and Savoy to those prodigious masses of snow which are precipitated, with a noise like thunder, and in large torrents, from the mountains, and which destroy every thing in their course, and have sometimes overwhelmed even whole villages. In 1719, an avalanche from a neighbouring glacier overspread the greater part of the houses and baths at Leuk, and destroyed a considerable number of inhabitants. The best preservative against their effects being the forests, with which the Alps abound, there is scarcely a village situated at the foot of a mountain that is not sheltered by trees; which the inhabitants preserve with uncommon reverence. Thus, what constitutes one of the principal beauties of the country affords also security to the people.

AVAST, in the sea language, a term requiring to stop, to hold, or to stay.

AUBLETIA, in botany, so named from M. Aublet, the author of the history of plants in Guiana, a genus of the Polyandria Monogynia class and order. Essential character, calyx five-leaved; corolla five-petalled; capsule many celled, echinate, with many seeds in each cell. There are four species, natives of Guiana.

AUCTIONS, and Auctioneers, every person exercising the trade of an auctioneer, within the bills of mortality, shall pay 20*s*. for a licence; and without the bills of mortality, 5*s*. Auctions and auctioneers are regulated by several statutes during the present reign A bidder at an auction, under the usual conditions that the highest bidder shall be the purchaser, may retract his bidding any time before the hammer is down.

AUCUBA, a genus of the Monoecia Tetrandria. Essential character, male four-toothed; corolla four-petalled; berry one-seeded; female nectary none: nut one celled. One species, a large tree of Japan.

AUDIENCE, is the name of a court of justice, established in the West Indies by the Spaniards, answering in effect to the parliaments of France.

These courts take in several provinces, called also audiences, from the names of the tribunal to which they belong.

Audience is also the name of an ecclesiastical court held by the archbishop of Canterbury, wherein differences upon elections, consecrations, institutions, marriages, &c. are heard.

AUDITORY *nerves*, in anatomy, a pair of nerves arising from the medulla oblongata, with two trunks, the one of which is called the *portio dura*, hard portion; the other *portio mollis*, or soft portion. See Anatomy.

AVENA, in botany, *oat-grass*, class Triandria Digynia; natural order, Gramina. Generic character; calyx, glume generally many-flowered, two-valved, loosely collecting the flowers; valves lanceolate, acute, ventricose, loose, large, awnless; corolla two valved; lower valve harder than the calyx; the size of the calyx roundish, ventricose, acuminate at both ends, emitting from the back an awn spirally twisted, reflex; nectary two-leaved; leaflets lanceolate, gibbous at the base; stamina filaments three, capillary; anthers oblong, forked; pistil germ obtuse· styles two, reflex, hairy; stigma simple: pericarp none; corolla most firmly closed, grows to the seed, and does not gape; seed one, slender, oblong, acuminate at both ends, marked with a longitudinal furrow. There are many species, of which we notice A. sativa, cultivated oat. Of this there are four varieties, the white, black, brown, or red, and the blue oat; panicled; calyxes too-seeded; seeds very smooth, one-awned; annual; culm or straw upwards of two feet high; panicle various in different varieties, but always loose and pendulous; the two glumes or chaffs of the calyx are marked with lines, pointed at the end, longer than the flower and unequal; there are usually two flowers, and seeds in each calyx; they are alternate, conical; the smaller one is awnless; the larger puts forth a strong, two-coloured, bent awn, from the middle of the back. No botanist has been able to ascertain satisfactorily the native place of growth of this, or indeed of any other sort of grain now commonly cultivated in Europe. The varieties mentioned above have been long known and others have been introduced, as the Poland, the Friesland or Dutch, and the Siberian or Tartarian oat. The blue oat is probably what is called Scotch greys. The white sort is most common about London, and those countries where the inhabitants live much upon oat-cakes, as it makes the whitest meal. The black is more cultivated in the northern parts of England, as it is esteemed a hearty food for horses. The red oat is much cultivated in Derbyshire, Staffordshire, and Cheshire; it is a very hardy sort, and gives a good increase. The straw is of a brownish red colour, very heavy, and esteemed better food for horses than either of the former sorts. In Lincolnshire they cultivate the sort called the Scotch greys. The Poland oat has a short plump grain, but the thickness of the skin seems to have brought it into disrepute among farmers. Add to this, the straw is very short. It was sown by Mr. Lisle in 1709. Friesland or Dutch oat affords more straw, and is thinner skinned, and the grains mostly double. A white oat, called the potatoe oat in Cumberland, where it was lately discovered, promises, from the size of the grain and the length of the straw, to be the most valuable we possess; it is now very generally bought for sowing. The oat is a very profitable grain, and a great improvement to many estates in the North of England, Scotland, and Wales; for it will thrive in cold barren soils, which will produce no other sort of grain; it will also thrive on the hottest land; in short, there is no soil too rich or too poor, too hot or too cold, for it; and in wet harvests, when other grain is spoiled, this will receive little or no damage. The meal of this grain makes a tolerably good bread, and is the common food of the country people in the north. It is also esteemed for pottage and other messes, and in some places they make beer with it. The best time for sowing oats is in February or March, according as the season is early or late. The black and red oats may be sown a month earlier than the white, because they are hardier. The advantage of early sowing is proved by experiment. White oats, sown the last week in May, have produced seven quarters the acre; and in Hertfordshire they do not sow them till after they have done sowing barley, which is found to be a good practice, this oat being more tender than the others. Mr. Marshall mentions the blowing of the sallow as a direction for the sowing of this grain. He says, "most people allow four bushels of oats to an acre, but I am convinced that three bushels are more than enough; the usual produce is about 25 bushels to an acre, though I have sometimes known more than 30." But 40 bushels and more are certainly no unusual crop. The American species are 9 in number, according to Muhlenberg.

AVERAGE, in commerce, signifies the accidents and misfortunes which happen to ships and their cargoes, from the time of their loading and sailing to their return and unloading; and is divided into three kinds: 1. The simple or particular average, which consists in the extraordinary expenses incurred for the ship alone, or for the merchandizes alone. Such is, the loss of anchors, masts, and rigging, occasioned by the common accidents at sea; the damages which happened to merchandize by storm, prize, shipwreck, wet, or rotting; all which must be borne and paid by the thing which suffered the damage. 2. The large and common average, being those expenses incurred, and damages sustained, for the common good and security both of the merchandizes and vessels, consequently to be borne by the ship and cargo, and to be regulated upon the whole. Of this number are the goods or money given for the ransom of the ship and cargo, things thrown over-board for the safety of the ship, the expenses of unlading for entering into a river or harbour, and the provisions and hire of the sailors when the ship is put under an embargo. 3. The small averages, which are the expenses for towing and piloting the ship out, off, or into harbours, creeks, or rivers, one-third of which must be charged to the ship, and two-thirds to the cargo.

Average is more particularly used for a certain contribution that merchants make proportionably towards their losses. It also signifies a small duty, which those merchants who send goods in another man's ship pay to the master for his care of them, over and above the freight. Hence it is expressed in the bills of lading, paying so much freight for the said goods, with primage and average accustomed.

AVERRHOA, in botany, a genus of the Decandria Pentagynia class of plants, whose flower consists of five lanceolated petals; the fruit is an apple of a turbinated and obtuse pentagonal figure, containing five cells, wherein are disposed angular seeds, separated by membranes. There are two species, trees, natives only of India, and other warm parts of Asia; singular for the fruit growing frequently on the trunk itself, below the leaves. The flower resembles that of the geranium; but the fruit is totally different: it is a poma, five-celled, and containing many seeds. The A. bilimbi is described as a beautiful tree, with green flesh fruit, filled with a grateful acid juice; the substance and seeds not unlike those of a cucumber: it grows from top to bottom, at all the knots and branches. A syrup is made of the juice, and a conserve of the flowers.

AVES, *birds*, the name of the second class of animals, according to the Linnæan system. They have been described as animals, having a body covered with feathers and down; jaws protracted and naked; two wings, formed for flight, and two feet. They are aereal, vocal, swift, and light, and destitute of external ears, lips, teeth, scrotum, womb, bladder, epiglottis, corpus callosum and its arch, and diaphragm. The feathers are disposed ouer each other in the form of a quincunx, intermixed with down, distinct from the quill and tail feathers, convex above, concave beneath, narrower on the outside, lax at the fore-end, hollow and horny at the base, with a central pith, and furnished on each side the elongated shaft with parallel, approximate, distinct, and flat laminæ, composing the vane; they vary in colour according to age, sex, season, or climate, except the quill and tail feathers, which are more constant, and chiefly characteristic. The eggs are various in number, size, and colour, but always covered with calcareous shell, deposited in an artificial nest, and hatched by the genial warmth of the parent. The body is oval, terminated by a heart-shaped rump, and furnished all over with aereal receptacles, communicating with the lungs or throat, necessary for flight or song, and which may be filled or emptied at pleasure; the rump has two glands, secreting an unctuous fluid, which is pressed out by the bill, to anoint the discomposed parts of the feathers; the bill is horny, extending from the head, either hooked at the end for tearing the prey, or slender for searching in the mire, or flat and broad for gobbling; and is used for building nests, feeding the young, climbing, or as an instrument of offence and defence; eyes lateral, furnished with orbits, and nictitant membrane; ears truncate, without auricles; wings compressed, consisting of moveable joints, and covered with quills and feathers; legs placed usually near the centre of gravity, with toes and claws of various shapes: tail serving as the rudder or director of the body; they are mostly monogamous, or live in single pairs, and migrate into milder climates, upon defect of food or warmth, and a few become torpid in winter. The generic characters are taken from the bill, tongue, nostrils, ceræ, caruncles, and other naked parts. See Plate I. Aves.

Fig. 1. *a.* Spurious or bastard wings; *b.* lesser coverts of the wings, which are small feathers that lie in several rows on the bones of the wings; *c.* greater wing coverts or feathers, that lie immediately over the quill feathers; *d.* scapulars, which take their rise from the shoulders, and cover the sides of the back; *e.* primary quill-feathers, that rise from the first bone; *f.* secondary quill-feathers, or those that rise from the second bone; *g.* tertials, which likewise take their rise from the second bone, forming a continuation of the secondaries, and seem to do the same with the scapulars that lie over them; these feathers are so long in some of the scolopax and tringa genera, that, when the bird is flying, they give it the appearance of having four wings; *h.* rump; *i.* tail-coverts; *k.* tail-feathers; *l.* shoulders; *m.* crown; *n.* front; *o.* hindhead; *p.* nape; *q.* chin; *r.* throat: *s.* scrag or neck above; *t.* interscapular region; *u.* vent.

Fig. 2. *a.* Upper mandible; *b.* lower mandible; *c.* a tooth-like process; *d.* frontlet; *e.* front; *f.* crown; *g.* hindhead; *h.* nape; *i.* lores; *k.* temples; *l.* cheeks; *m.* chin; *n.* bristles at the base of the bill.

Fig. 3. *a.* A bill with the upper mandible hooked at the point, and furnished with a tooth-like process; *b.* the cere or naked skin which covers the base of the bill, and in which are placed the nostrils; *c.* orbits, or skin, which surrounds the eye: it is generally bare, but particularly in the parrot and heron.

Fig. 4. A flat bill, pectinate at the edges, and furnished at the tip with a claw or nail.

Fig. 5. A foot formed for perching, having three toes before and one behind.

Fig. 6. A walking foot, having a spur on the heel.

Fig. 7. A climbing foot, having two toes before and two behind.

Fig. 8. A palmate or webbed foot.

Fig. 9. A semi-palmate or half-webbed foot.

Fig. 10. A pinnate or finned foot.

Fig. 11. A lobate foot.

There are six orders of birds, each of which contains several genera, that will be noticed in their proper places. The orders are,

1. Accipitres or rapacious kind.
2. Picæ or pye kind.
3. Anseres or duck kind.
4. Grallæ or crane kind.
5. Gallinæ or poultry kind.
6. Passeres or sparrow kind.

We may observe, with regard to this class of animals, the admirable contrivances, throughout the whole of their structure, for promoting their buoyancy in air, for enabling them to move with celerity, and for directing their course. Their covering is of the lightest kind; yet the down with which they are supplied under their feathers is the warmest that could be devised; for, in consequence of the air entangled as it were in its interstices, it is one of the slowest conductors of heat. The outer feathers, by their slanting disposition, and their natural oiliness, form a complete shelter to the body from wet; and the hollow structure of the wing feathers, by increasing their bulk without increasing their weight, renders them more buoyant in the air.

The whole form of the body is adapted to its flying with ease and celerity; the small head and sharp bill for diminishing the resistance of the air; the greater muscular strength, as well as an expansion of the wings, for impelling its body forward with celerity; and the broad feathers of the tail, moveable in almost every direction, for steering its course, like the rudder of a ship.

The disposition of the lungs along the back-bone, and their communications with the cells in the bones of the wings, thighs, and breast, by admitting air in almost every part of the body, increases the buoyancy of the whole, and enables the bird to exist longer without breathing, which must be in a great measure impeded, if not suspended, during some of its rapid flights.

It has been observed, that the brilliancy of the plumage in the feathered tribe is only to be looked for in the warmer regions of Asia, Africa, and America. This remark is, as a general one, perfectly correct; but whoever has seen the beautiful king-fisher dart along the shaded brook, cannot allow that our own country has nothing to boast in the brilliancy of its birds. The crimson crown of the wood pecker, the beautiful bars of black, blue, and white, on the greater wing-coverts of the blue-jay, and the elegant plumage of the pheasant, as well as the extreme beauty of the flicker or gold winged wood-pecker, and the waxen chatterer, or cedar bird, the cerulean tints of the blue-bird, and splendours of the ruby-throated humming-bird, prove that nature has not confined her works of elegance to regions within the tropics.

The whole class of birds differs essentially from all other animals in internal structure, as well as in external form and appearance; and every point of difference, when accurately examined, is evidently adapted to their peculiar habits. These will be noticed under the several orders and genera. To give but a single instance in this place: the accipitres have sight so piercing, that frequently, when so high as to be out of human ken, they can descry their prey upon the ground, and their flight is so rapid, that they can dart upon it with the celerity of a meteor. Their prey varies according to their strength and rapacity, from the lamb or kid, which the vulture bears away in his talons, to the smaller birds and mice, on which the hawk and owl tribes feast. To prevent the depredation that these would otherwise commit, nature has ordained that this tribe of birds should be the least prolific; few of them lay more than two eggs.

AUGEA, in botany, a genus of the Decandria Monogynia class and order. Calyx five-parted; corolla ov. nectary ten-toothed; capsule ten-celled. One species, a native of the Cape.

AUGITE, a mineral of the Chrysolite family, found in basalt, sometimes in grains, but most commonly in crystals, mostly small and complete. Colour blackish green, sometimes passing into leek green, and rarely to liver brown. Specific gravity 3.22 to 3.47. Before the blow-pipe it is with difficulty converted into a black enamel: the constituent parts are

Silica	52.00
Lime	13.20
Alumina	3.33
Magnesia	10.00
Oxide of iron	14.66
——— manganese	2.00
	95.19
Loss	4.81
	100.00

It is found very abundantly in Bohemia, Transylvania, Hungary, Scotland, as at Arthur's Seat, near Edinburgh, and remarkably fine in the island of Ruma, one of the Hebrides, and equally beautiful at Arendal, in Norway. Augite is distinguished from olivino by its darker colours, different crystallization, greater hardness, and specific gravity. It used to be considered as a product of fire; but the circumstance of its occurring wrapped up, not imbedded, in lava, demonstrates that it is one of the constituent parts of the mother-stone, which has escaped fusion.

AUGMENT, in grammar, an accident of certain tenses of Greek verbs, being either the prefixing of a syllable, or an increase of the quantity of the initial vowels.

Of these there are two kinds, the *augmentum temporale*, or of a letter, when a short vowel is changed into a long one, or a diphthong into another longer one; and *augmentum syllabicum*, or of a syllable, when a syllable is added at the beginning of the word.

AUGMENTATION, was the name of a court erected 27 Hen. VIII. so called, from the augmentation of the revenues of the crown by the suppression of religious houses; and the office still remains, wherein there are many curious records, though the court has been dissolved long since.

Augmentation, in heraldry, are additional charges to a coat-armour, frequently given as particular marks of honour, and generally borne either on the escutcheon or a canton; as have all the baronets of England, who have borne the arms of the province of Ulster, in Ireland.

Augmentation, in music, a term confined to the language of fuguists, and is the doubling the value of the notes of the subject of a fugue or canon: or, the giving the intervals of the subject in notes of twice the original length.

AUGRE, or **Awgre**, an instrument used by carpenters and joiners to bore large round holes, and consisting of a wooden handle and an iron blade, terminated at bottom with a steel bit.

AVIARY, a place set apart for feeding and propagating birds. It should be so large as to give the birds some freedom of flight; and turfed, to avoid the appearance of foulness on the floor.

AVICENA, **Ebu Sina**, in biography, has been accounted the prince of Arabian philosophers and physicians. He was born at Assena, near Bokhara, in 978; and died at Hamadan in 1036, being 58 years of age.

The first years of Avicena were employed in the study of the Belles Lettres, and the Koran, and at ten years of age he was perfect master of the hidden senses of that book. Then applying to the study of logic, philosophy, and mathematics, he quickly made a rapid progress. After studying under a master the first principles of logic, and the first five or six propositions of Euclid's elements, he became disgusted with the slow manner of the schools, applied himself alone, and soon accomplished all the rest by the help of the commentators only.

Possessed with an extreme avidity to be acquainted with all the sciences, he studied medicine also. Persuaded that this art consists as much in practice as in theory, he sought all opportunities of seeing the sick; and afterwards confessed, that he had learned more from such experience than from all the books he had read. Being now in his sixteenth year, and already celebrated for being the light of his age, he determined to resume his studies of philosophy, which medicine, &c. had made him for some time neglect: and he spent a year and a half in this painful labour, without ever sleeping all this time a whole night together. At the age of 21, he conceived the bold design of incorporating in one work all the objects of human knowledge; and he carried it into execution in an Encyclopedia of 20 volumes, to which he gave the title of the "Utility of Utilities."

Many wonderful stories are related of his skill in medicine, and the cures which he performed. Several princes had been taken dangerously ill, and Avicena was the only one that could know their ailments, and cure them. His reputation increased daily, and all the princes of the East desired to retain him in their families, and in fact he passed through several of them. But the irregularities of his conduct sometimes lost him their favour, and threw him into great distresses. His excesses in pleasures, and his infirmities, made a poet say, who wrote his epitaph, that the profound study of philosophy had not taught him good morals, nor that of medicine the art of preserving his own health.

After his death, however, he enjoyed so great a reputation, that, till the 12th century, he was preferred for the study of philosophy and medicine to all his predecessors. Even in Europe, his works, which were very numerous, were the only writings in vogue in the schools.

AVICENNIA, in botany, so named in honour of a celebrated oriental physician, who flourished in the eleventh century at Ispahan, a genus of the Didynamia Angiospermia class and order. Essential character: calyx five-parted; corolla two-lipped, the upper lip square; capsule coriaceous, rhomboid, one-seeded. There are three species, natives of the East and West Indies. A. tomentosa, a tree, agrees mostly with the mangrove, rising about 15 feet; its trunk is not so large, having a smooth, whitish green bark, and from the stem are twigs propagating the tree like that: the branches at top are jointed towards their ends, where the leaves come out opposite, on very small petioles, two inches and a half long, and about an inch broad: the flowers are many, at the top of the branches, white and tetrapetalous. It is found on the north and south sides of Jamaica, growing in low moist ground. A. nitida grows forty feet high, a native of Martinico: the creeping roots throw up abundance of suckers. A. resinifera produces a green coloured gum, so much esteemed by the natives of New Zealand, and which is very hot in the mouth.

AVIGNON *berry*, taken from the rhamnus infectorius, and used in France by dyers for making a yellow colour. They are gathered unripe, bruised, and boiled in water, mixed with the ashes of vine stalks, to give a body, and then strained through linen. The colour is chiefly used for silk, but it will not well bear the heat of the sun. The plant grows, as its name imports, in the neighbourhood of Avignon.

AULA *regis*, was a court established by William the Conqueror in his own hall. It was composed of the king's great officers of state resident in his palace, who usually attended on his person, and followed him in all his progresses and expeditions; which being found inconvenient and burthensome, it was enacted, by the great charter, c. 11, that common pleas shall no longer follow the king's court, but shall be holden in some certain place, which certain place was established in Westminster Hall, where the aula regis originally sat when the king resided in that city, and there it has ever since continued. 3 Black. 37.

AULIC, an epithet given to certain officers of the empire, who composed a court, which decides, without appeal, in all processes entered in it. Thus we say aulic council, aulic chamber, aulic counsellor. The aulic council is composed of a president, who is a Catholic; of a vice-chancellor, presented by the archbishop of Mentz; and of eighteen counsellors, nine of whom are Protestants, and nine Catholics. They are divided into a bench of lawyers, and always follow the emperor's court, for which reason they are called *justitium imperatoris*, the emperor's justice, and aulic council. The aulic court ceases at the death of the emperor, whereas the imperial chamber of Spire is perpetual, representing not only the deceased emperor, but the whole Germanic body, which is reputed never to die.

AVOIRDUPOIS, or **Averdupois** *weight*, a sort of weight used in England, the pound whereof is made up of sixteen ounces.

This is the weight for the larger and coarser commodities, such as groceries, cheese, wool, lead, &c. Bakers, who live not in corporation-towns, are to make their bread by avoirdupois weight; those in corporations, by troy weight. Apothecaries buy by avoirdupois weight, but sell by troy. The avoirdupois ounce is less than the troy ounce, in the proportion of 700 to 768; but the avoirdupois pound is greater than the troy pound, in the proportion of 700 to 576, or as 17 to 14 nearly: for

1 *lb.* avoirdupois = 7000 *grains* troy.
1 *lb.* troy . . = 5760 . . do.
1 *oz.* avoirdupois = 437½ . . do.
1 *oz.* troy . . = 480 . . do.

AVOWEE, one who has a right to present to a benefice. See Advowson.

AURELIA, in natural history, a term formerly employed by naturalists to express that intermediate state, in which all lepidopterous, and most other insects, remain for some time, between the caterpillar form and the period in which they are furnished with wings, with antennæ, and other organs appertaining to the perfect insect. Aurelia and crysalis are synonimous words, both alluding to the golden splendour of the case in which the creature, during that state, is contained. This brilliant appearance seems to be confined to the Papilio tribe, so that the terms aurelia and crysalis are altogether inapplicable, in a general manner, to insects in that state. These terms are now discarded in favour of the more expressive one *pupa*, which Linnæus has adopted in their stead; a term which implies that the insect, like an infant, remains in its swaddling clothes.

AURICLE, in anatomy, that part of the ear which is prominent from the head, called by many authors *auris externa*.

Auricles *of the heart*. These are a kind of appendages of the heart at its base, and are distinguished by the names of the right and left. The right auricle is much larger than the left, and this is placed in the hinder, that in the anterior part. They are intended as diverticula for the blood, during the systole. Their substance is muscular, being composed of strong fibres, and their motion is not synchronous, but achronous, with that of the heart. See Anatomy.

AURICULAR *medicines*, such as are used in the cure of distempers in the ear.

AURIGA, the *Waggoner*, in astronomy, a constellation of the northern hemisphere, consisting of 23 stars, according to Tycho, 40 according to Hevelius, and 66 in the Britannic catalogue. This constellation is represented by the figure of an old man, in a posture somewhat like sitting, with a goat and her kids in his left hand, and a bridle in his right.

AURORA *borealis*, or **Aurora** *septentrionalis*, in physiology, the northern dawn or light, sometimes called streamers, is an extraordinary meteor, or luminous appearance, shewing itself in the night-time in the northern part of the heavens; and most usually in frosty weather. It is usually of a reddish colour, inclining to yellow, and sends out frequent corruscations of pale light, which seem to rise from the horizon in a pyramidal undulating form, and shoot with great velocity up to the zenith. The aurora borealis appears frequently in form of an arch, chiefly in the spring and autumn after a dry year. The arch is partly bright, partly dark, but generally transparent; and the matter of which it consists is also found to have no effect on the rays of light which pass through it. Dr. Hamilton observes, that he could plainly discern the smallest speck in the Pleiades, through the density of those clouds which formed the aurora borealis in 1763, without the least diminution of its splendour, or increase of twinkling.

This kind of meteor, which is more uncommon as we approach towards the equator, is almost constant during the long winter, and appears with the greatest lustre in the polar regions. In the Shetland isles, the "merry dancers," as the northern lights are there called, are the constant attendants of clear evenings, and afford great relief amidst the gloom of the long winter nights. They commonly appear at twilight, near the horizon, of a dun colour, approaching to yellow; they sometimes continue in that state for several hours, without any perceptible motion; and afterwards they break out into streams of stronger light, spreading into columns, and altering slowly into 10,000 different shapes, and varying their colours from all the tints of yellow to the most obscure russet. They often cover the whole hemisphere, and then exhibit the most brilliant appearance. Their motions at this time are most amazingly quick; and they astonish the spectator with the rapid change of their form. They break out in places where none were seen before, skimming briskly along the heavens, are suddenly extinguished, and are succeeded by an uniform dusky tract. This again is brilliantly illuminated in the same manner, and as suddenly left a dark space. In some nights they assume the appearance of large columns, on one side of the deepest yellow, and on the other gradually changing, till it becomes undistinguished from the sky. They have generally a strong tremulous motion from one end to the other, and this continues till the whole vanishes. As for us, who see only the extremities of these northern phenomena, we can have but a faint idea of their splendour and motions. According to the state of the atmosphere, they differ in colour; and sometimes assuming the colour of blood, they make a dreadful appearance. The rustic sages, who observe them, become prophetic, and terrify the spectators with alarms of war, pestilence, and famine: nor, indeed, were these superstitious presages peculiar to the northern islands: appearances of a similar nature are of ancient date; and they were distinguished by the appellations of "phasmata," "trabes," and "bolides," according to their forms and colours. In old times they were either more rare, or less frequently noticed: but when they occurred, they were supposed to portend great events, and the timid imagination formed of them aerial conflicts.

In the northern latitudes of Sweden and Lapland, the auroræ borealis are not only singularly beautiful in their appearance, but afford travellers, by their almost constant effulgence, a very beautiful light during the whole night. In Hudson's bay, the aurora borealis diffuses a variegated splendour, which is said to equal that of the full moon. In the north-eastern parts of Siberia, according to the description of Gmelin, these northern lights are observed to "begin with single bright pillars rising in the north, and almost at the same time in the north-east, which, gradually increasing, comprehend a large space of the heavens, rush about from place to place with incredible velocity, and, finally, almost cover the whole sky up to the zenith, and produce an appearance as if a vast tent was expanded in the heavens, glittering with gold, rubies, and sapphire. A more beautiful spectacle cannot be painted; but whoever should see such a northern light for the first time, could not behold it without terror. For, however fine the illumination may be, it is attended, as I have learned from the relation of many persons, with such a hissing, cracking, and rushing noise through the air, as if the largest fire-works were playing off. To describe what they then hear, they make use of the expression 'spolochi chodjat,' that is, 'the raging host is passing.' The hunters, who pursue the white and blue foxes in the confines of the Icy sea, are often overtaken in their course by these northern lights. Their dogs are then so much frightened, that they will not move, but lie obstinately on the ground, till the noise has passed. Commonly, clear and calm weather follows this kind of northern lights. I have heard this account, not from one person only, but confirmed by the uniform testimony of many, who have spent part of several years in these very northern regions, and inhabited different countries, from the Yenisei to the Lena; so that no doubt of its truth can remain. This seems indeed to be the real birth place of the aurora borealis."

This account of the noises attending the aurora borealis, allowing for some degree of exaggeration, has been corroborated by other testimonies. A person, who resided seven years at Hudson's Bay, confirms M. Gmelin's relation of the fine appearance and brilliant colours of the northern lights, and particularly of their rushing noise, which he affirms he has frequently heard, and compares it to the sound produced by whirling round a stick swiftly at the end of a string. A similar noise has also been heard in Sweden. Mr. Nairne also, being in Northampton at a time when the northern lights were remarkably bright, is confident he perceived a hissing or whizzing sound. Mr. Belknap, of Dover, in New Hampshire, North America, testifies to this fact. M. Cavallo says, that the crackling noise is distinctly audible, and that he has heard it more than once. Similar lights, called auroræ australes, have been long since observed towards the south pole, and their existence has been more lately ascertained by Mr. Forster, who assures us, that, in his voyage round the world with Captain Cooke, he observed them in high southern latitudes, though attended with phenomena somewhat different from those which are seen here. On February 17, 1773, in south latitude 58°, "a beautiful phenomenon (he says) was observed during the preceding night, which appeared this and several following nights. It consisted of long columns of a clear white light, shooting up from the horizon to the eastward, almost to the zenith, and gradually spreading on the whole southern part of the sky. These columns were sometimes bent sideways at their upper extremities; and though in most respects similar to the northern lights (aurora borealis) of our hemisphere, yet differed from them in being always of a whitish colour, whereas ours assume various tints, especially those of a fiery and purple hue. The sky was generally clear when they appeared, and the air sharp and cold, the thermometer standing at the freezing point."

The periods of the appearance of these northern lights are very inconstant. In some years they occur very frequently, and in others they are more rare; and it has been observed, that they are more common about the time of the equinoxes than at other seasons of the year. Dr. Halley (see Philos. Trans. No. 347, p. 406,) has collected together several observations, which form a kind of history of this phenomenon. After having particularly described the various circumstances which attended that observed by himself and many others, in March 1716, and which was singularly brilliant, he proceeds with informing us, that the first account of similar phenomena, recorded in the English annals, is that of the appearance which was noticed January 30, 1560, and called "burning spears," by the author of a book, entitled "A Description of Meteors," by W. F. D. D. reprinted at London, in 1654. The next appearance of a like kind, recorded by Stow, occurred on October 7, 1564. In 1574, as Camden and Stow inform us, an aurora borealis was seen for two successive nights, *viz.* 14th and 15th of November, with appearances similar to those observed in 1716, and which are now commonly noticed. The same phenomenon was twice seen in Brabant, in 1575, *viz.* on the 13th of February and the 28th of September; and the circumstances attending it were described by Cornelius Gemma, who compares them to spears, fortified cities, and armies fighting in the air. In the year 1580, M. Mastline observed these phasmata, as he calls them, at Baknang, in the county of Wirtemberg, in Germany, no less than seven times in the space of twelve months; and again at several different times, in 1581. On September 2d, 1621, the same phenomenon was seen over all France; and it was particularly described by Gassendus, in his "Physics," who gave it the name of "aurora borealis." Another was seen all over Germany in November, 1623, and was described by Kepler. Since that time, for more than eighty years, we have no account of any such phenomenon, either at home or abroad. In 1707, Mr. Neve observed one of small continuance in Ireland; and in the same year, a similar appearance was seen by Romer, at Copenhagen; and during an interval of eighteen months, in the years 1707 and 1708, this sort of light had been seen no less than five times. Hence it should seem, says Dr. Halley, that the air, or earth, or both, are not at all times disposed to produce this phenomenon, though it is possible it may happen in the day time, in bright moon shine, or in cloudy weather, and so pass unobserved. Dr. Halley further observes, that the aurora borealis of 1716, which he described, was visible from the west of Ireland to the confines of Russia, and to the east of Poland; extending at least near 30° of longitude, and from about the 50th degree of north latitude, over almost all the north of Europe; and in all places, at the same time, it exhibited appearances similar to those which he observed at London. He regrets, however, that he was unable to determine its height, for want of contemporary obervations at different places.

Father Boscovich has determined the height of an aurora borealis, observed on the 16th of December, 1737, by the Marquis of Poleni, to have been 825 miles; and Mr. Bergman, from a mean of thirty computations, makes the average height of the aurora borealis to be 72 Swedish, or (supposing a Swedish mile to be about 6½ English miles) 468 English miles. Euler supposes the height to be several thousands of miles; and Mairan also assigns to these phenomena a very elevated region, the far greater number of them being, according to him, about 200 leagues above the surface of the earth. Dr. Blagden, speaking of the height of some fiery meteors, (Phil. Trans. vol. lxxiv. p. 227,) says, that "the aurora borealis appears to occupy as high, if not a higher, region above the surface of the earth, as may be judged from the very distant countries to which it has been visible at the same time;" he adds, that "the great accumulation of electric matter seems to lie beyond the verge of our atmosphere, as estimated by the cessation of twilight." However, the height of these meteors, none of which appear to have ascended so high as 100 miles, is trivial, compared with the elevations above ascribed to the aurora borealis.

But as it is difficult to make such observations on this phenomenon as are sufficient to afford a just estimate of its altitude, they must be subject to considerable variation, and to material error.

It is not improbable, that the highest regions of the aurora borealis are the same with those in which fire-balls move; more especially as Dr. Blagden informs us, that instances are recorded, in which the northern lights have been seen to join, and form luminous balls, darting about with great velocity, and even leaving a train behind like the common fire-balls. This ingenious author, however, conjecturing that distinct regions are allotted to the electrical phenomena of our atmosphere, assigns the appearance of fire-balls to that region which lies beyond the limits of our crepuscular atmosphere; and a greater elevation above the earth to that accumulation of electricity, in a lighter and less condensed form, which produces the wonderfully diversified streams and coruscations of the aurora borealis.

AUSTRAL, something relating to the south: thus the six signs on the south side of the equinoctial are called austral signs.

AUTER *fois acquit*, in law, a plea made by a criminal, that he has been already acquitted of the same crime with which he is charged. There are likewise pleas of auter fois convict and attaint, that he has been before convicted of the same felony.

AUTHENTIC, something of acknowledged and received authority. In law, it signifies something clothed in all its formalities, and attested by persons to whom credit has been regularly given. Thus, we say, authentic papers, authentic instruments. In music, authentic is a term applied to four of the church modes or tones, which rise a fourth above their dominants, which are always a fifth above their finals; in this distinguished from the plegal modes, which fall a fourth below their finals. Thus, when an octave is divided arithmetically, according to the numbers, 2, 3, 4, that is, when the fifth is flat, and the fourth sharp, the mode or tone is called authentic, in contradistinction to the plegal tone, where the octave is divided harmonically by the numbers 3, 4, 6, which makes the fourth a flat, and the fifth a sharp.

AUTHORITY, in a general sense, signifies a right to command, and make one's self obeyed.

AUTHORITY, in law, signifies a power given, by word or writing, to a second person to act something, and may be by writ, warrant, commission, letter of attorney, &c. and sometimes by law. An authority given to another, to do what a person himself cannot do, is void; and it must be for doing a thing that is lawful, otherwise it will be no good authority.

Authority is represented, in painting, like a grave matron sitting in a chair of state, richly clothed in a garment embroidered with gold, holding in her right hand a sword, and in her left a sceptre. By her side is a double trophy of books and arms.

AUTOGRAPHUM, the very hand writing of a person, or the original manuscript of a treatise or discourse. Autographa, or original manuscripts of the New Testament, are the copies written by the apostles, or by amanuenses under their immediate inspection. St. Paul seems generally to have adopted the latter mode; but, to prevent the circulation of spurious epistles, he wrote the concluding benediction with his own hand. The early loss of the autographa of the New Testament affords matter of surprise, when it is known that the original manuscripts of Luther, and other eminent men, who lived at the time of the reformation, are still subsisting.

AUTOMATUM, or AUTOMATON, an instrument, or rather machine, which, by means of springs, weights, &c. seems to move itself, as a watch, clock, &c. Such also were Archytus's flying dove, Regiomontanus's wooden eagle, &c. See ANDROIDES.

AUTUMN, the third season of the year, when the harvest and fruits are gathered in. Hence, in the language of the Alchemists, it signifies the time when the philosopher's stone is brought to perfection.

Autumn is represented, in painting, by a man at perfect age, clothed like the vernal, and likewise girded with a starry girdle; holding in one hand a pair of scales equally poised, with a globe in each; in the other, a bunch of divers fruits and grapes. His age denotes the perfection of this season, and the balance, that sign of the zodiac which the sun enters when our autumn begins.

AUTUMNAL *signs*, in astronomy, are the signs Libra, Scorpion, and Sagittarius, through which the sun passes during the autumn.

AUXILIARY *verbs*, in grammar, are such as help to form or conjugate others; that is, are prefixed to them, to form or denote the moods or tenses thereof. As *to have* and *to be* in the English; *estre* and *avoir* in the French; *ho et sono* in the Italian, &c. In the English language, the auxiliary verb *am* supplies the want of passive verbs.

Auxiliary, in military affairs: by this term is understood foreign or subsidiary troops, which are furnished to a belligerent power in consequence of a treaty of alliance, or for pecuniary considerations. Of the latter description may be considered the Swiss soldiers who formerly served in France, and the Hessians, who were employed by Great Britain during a part of the American war, and on other occasions.

AUXILIUM *curiæ*, in law, a precept or order of court, to cite, or convene one party at the suit of another.

Auxilium *ad filium militem faciendum, vel filiam maritandam*, a precept or writ directed to the sheriff of every county, where the king, or other lords, had any tenants, to levy of them reasonable aid, towards the knighting his eldest son, or the marriage of his eldest daughter.

AWAIT, in law, way-laying, or laying-in-wait to execute some mischief. It is enacted that no charter of pardon shall be allowed before any justice, for the death of a man slain by await or malice prepense, 13 Rich. II.

AWARD, in law, the judgment of an arbitrator, or of one who is not appointed by the law a judge, but chosen by the parties themselves for terminating their difference. See Arbitrator.

AWL, or Aul, among shoemakers, an instrument wherewith holes are bored through the leather, to facilitate the stitching or sewing the same. The blade of the awl is usually a little flat and bended, and the point ground to an acute angle.

AWME, or Aume, a Dutch liquid measure, containing eight steckans, or twenty verges or verteels, equal to the tierce in England, or to one-sixth of a ton of France.

AWN. See Arista.

AWNING, in the sea-language, is the hanging a sail, tarpauling, or the like, over any part of the ship, to keep off the sun, rain, or wind. That part of the poop-deck which is continued forward beyond the bulk-head of the cabin, is also called the awning.

AXETONE. See Nephrite.

AXILLA, in anatomy, the arm-pit, or the cavity under the upper part of the arm.

Axilla, in botany, the space comprehended betwixt the stems of plants and their leaves.

AXIOM, in philosophy, is such a plain, self-evident, and received notion, that it cannot be made more plain and evident by demonstration; because it is itself better known than any thing that can be brought to prove it; as, that nothing can act where it is not; that a thing can be, and not be, at the same time; that the whole is greater than a part thereof; and that from nothing, nothing can arise. By axioms, called also maxims, are understood all common notions of the mind, whose evidence is so clear and forcible, that a man cannot deny them, without renouncing common sense and natural reason.

The rule whereby to know an axiom is this: whatever proposition expresses the immediate clear comparison of two ideas, without the help of a third, is an axiom. But if the truth does not appear from the immediate comparison of two ideas, it is no axiom.

These sorts of propositions, under the name of axioms, have, on account of their being self-evident, passed not only for principles of science, but have been supposed innate, and thought to be the foundation of all our other knowledge; though, in truth, they are no more than identic propositions; for to say that all right angles are equal to each other, is no more than saying that all right angles are right angles, such equality being implied in the very definition. All considerations of these maxims, therefore, can add nothing to the evidence or certainty of our knowledge of them; and how little they influence the rest of our knowledge, how far they are from being the foundation of it, as well as of the truths first known to the mind, Mr. Locke, and some others, have undeniably proved. According to Bacon, it is impossible that axioms raised by argumentation should be useful in discovering new works; because the subtilty of nature far exceeds the subtilty of arguments; but axioms, duly and methodically drawn from particulars, will again easily point out new particulars, and so render the sciences active.

The axioms in use being derived from slender experience, and a few obvious particulars, are generally applied in a corresponding manner. No wonder, therefore, they lead us to few particulars; and if any instance, unobserved before, happen to turn up, the axiom is preserved by some trifling distinction, where it ought rather to be corrected.

Axiom is also an established principle in some art or science.

Thus, it is an established axiom in physics, that nature does nothing in vain; so it is in geometry, that if to equal things you add equals, the sums will be equal. It is an axiom in optics, that the angle of incidence is equal to the angle of reflection, &c. In which sense, too, the general laws of motion are called axioms: whence it may be observed, that these particular axioms are but deductions from certain hypotheses.

AXIS, in geometry, the straight line in a plane figure about which it revolves, to produce or generate a solid: thus, if a semicircle be moved round its diameter at rest, it will generate a sphere, the axis of which is that diameter.

Axis, in astronomy. 1. Axis of the world, an imaginary right line conceived to pass through the centre of the earth, from one pole to the other, about which the sphere of the world, in the Ptolemaic system, revolves in its diurnal rotation. 2. The axis of a planet is that line drawn through the centre about which the planet revolves. The sun, together with all planets, except Mercury, Saturn, and Herschel, are known, by observation, to move about their respective axes. The axis of the earth, during its revolution round the sun, remains parallel to itself, and is inclined to the plane of the ecliptic, making with it an angle of 66½ degrees. 3. The axes of the equator, horizon, ecliptic, zodiac, &c. are right lines drawn through the centres of those circles perpendicular to their planes.

Axis, in conic sections, a right line dividing the section into two equal parts, and cutting all its ordinates at right angles. See Conic Sections.

Axis, in mechanics. The axis of a balance is that line about which it moves, or rather turns about. Axis of oscillation is a right line parallel to the horizon, passing through the centre about which a pendulum vibrates.

Axis *in peritrochio*, one of the five mechanical powers, consisting of a peritrochium or wheel, concentric with the base of a cylinder, and moveable together with it, about its axis. See Mechanics.

Axis, in optics, is that ray, among all others that are sent to the eye, which falls perpendicularly upon it, and which consequently passes through the centre of the eye.

Axis of a glass or lens, is a right line joining the middle points of the two opposite surfaces of the glass.

Axis of incidence, in dioptrics, is a right line perpendicular, in the point of incidence, to the refracting superficies, drawn in the same medium that the ray of incidence comes from.

Axis of refraction, is a right line drawn through the refracting medium, from the point of refraction, perpendicular to the refracting superficies.

AXYRIS, in botany, a genus of the Monoecia Triandria class of plants, in the male flowers of which the calyx is a perianthium composed of four patent, obtuse leaves, divided into three segments: there is no corolla: in the female flowers the calyx is composed of five obtuse, concave, connivent, and permanent leaves, with the two exterior ones shorter than the rest; there is no corolla; nor is there any pericarpium; the seed is single, oblong, compressed, obtuse, and contained in the cup.

AYE-*aye*, in natural history, a singular quadruped, discovered by Sonnerat, in the island of Madagascar, and described in his voyage to the East Indies. Sonnini forms a new genus of this animal, under the name of "Chieromys," but Gmelin ranks it under the genus "Sciurus," which see.

AYENIA, in botany, so called in honour of the Duke d'Ayen, a great promoter of the science of botany, of the Gynandria Pentandria class and order. Natural order of Columniferæ. Malvaceæ Jussieu. Essential character, monogynous. Calyx five-leaved. Petals united into a star, with long claws; five anthers under the star; capsule five-celled. There are four species; of which three are natives of South America, and one of Jamaica. These plants are propagated by seeds, sown in the spring, in hot-beds, where they must continue; but they will want a good portion of free air. If exposed to the open atmosphere, they will not thrive; and if too much drawn, they do not flower well. The plant will live through the winter, but as they perfect their seeds the first year, the old plants are seldom continued.

AZALEA, in botany, of the Pentandria Monogynia class and order. Natural order, Bicornes; Rhododendra, Jussieu. Essential character, corolla bell-shaped; stamina inserted into the receptacle; capsule five-celled. There are seven species. A. Pontica much resembles the rhododendron ponticum, but it has five stamens and yellow corollas, not ten stamens and violet-coloured corollas, as that has. The leaves are smaller, ovate, and ciliate; a native of Pontus. A. indica is a shrub three feet in height, with a trunk an inch thick, having a rough cinereous brown bark; the branches are short, twisted and irregular; leaves stiff villose, close and evergreen; beautiful bright red flowers cover the whole upper part of the shrub. Native of the East Indies; much cultivated in Japan for the elegance of its flowers, and the variety in their size and colours. A. viscosa is a low shrub, rising with several slender stems nearly four feet high. The leaves come out in clusters at the ends of the shoots, without order: the flowers come forth in clusters between the leaves, and have the appearance of those of the honey-suckle, and are as agreeably scented. They appear in the middle of July, but do not bring forth seeds in England. The Pontic and Indian species have not yet been cultivated in Europe. The Viscosa grows naturally in shade, and upon moist ground, in most parts of North America, from whence many of the plants have been sent of late years to England, and several of them have produced their beautiful flowers. They must have a moist soil, and a shady situation, otherwise they will not thrive; they can only be propagated by shoots from their roots, and laying down their branches. The best time for laying down the young shoots is at Michaelmas, and if they are covered with some old tan, to keep out the frost, it will be of great use to them.

AZIMUTH, in astronomy, an arch of the horizon, intercepted between the meridian of the place and the azimuth, or vertical circle passing through the centre of the object, which is equal to the angle of the zenith formed by the meridian and vertical circle; or it is found by this proportion: As the radius to the tangent of the latitude of the place, so is the tangent of the sun's or star's altitude, for instance, to the co-sine of the azimuth from the south, at the time of the equinox.

Azimuth, *magnetical*, an arch of the horizon, intercepted between the azimuth, or vertical circle, passing through the centre of any heavenly body and the magnetical meridian.

This is found by observing the object with an azimuth compass.

Azimuth *compass*, an instrument adapted to find, in a more accurate manner than by the common sea-compass, the sun or star's magnetical amplitude, or azimuth. It is also used to take the bearings of head-lands, ships, and other objects at a distance. The azimuth compass differs from the common sea-compass in this, that the circumference of the card, or box, is divided into degrees, and there is fitted to the box an index with two sights, which are upright pieces of brass placed diametrically opposite to each other, having a slit down the middle of them, through which the sun, or star, or other object, is to be viewed, at the time of observation. See Compass.

Azimuth *dial*, one whose style or gnomon is at right angles to the plane of the horizon.

Azimuth *circles*, called azimuths, or vertical circles, are great circles of the sphere, intersecting each other in the zenith and nadir, and cutting the horizon at right angles in all the points thereof.

The horizon being divided into 360°, there are reckoned 360 azimuths.

These azimuths are represented by the rhumbs on common sea charts, and on the globe they are represented by the quadrant of altitude when screwed in the zenith. On these azimuths is reckoned the height of the stars, and of the sun, when not in the meridian.

AZOTE, or *nitrogen*, in chemistry, a gas that forms the unrespirable part of the atmospheric air, and it exists in the proportion of about 78 per cent. by bulk, or 74 per cent. in weight. The properties by which this gas was first distinguished were principally negative, in direct opposition to those of oxygen, the other constituent of the atmosphere: the latter supporting combustion and animal life in an eminent degree, while the former was found to be immediately fatal to animals; hence its name azote, or the extinguisher of life. Oxygen also produces a great change in almost all metallic substances, which is known by the term oxydation; azote, on the contrary, not only extinguishes life and flame immediately, but produces no change whatever on combustible bodies immersed in it.

This gas is obtained by the following methods: if a quantity of iron filings and sulphur, mixed together, with a little water, be put into a glass receiver full of atmospheric air, it will in a few days absorb all the oxygen, and the remainder will be azote, or more properly azotic gas. Phosphorus may be substituted for the iron filings and sulphur, and the absorption will be completed in 24 hours. Diluted nitric acid, poured on muscular flesh, and the heat of 100° applied, will furnish azotic gas. By whatever means obtained, its properties are always the same; *viz.* it is invisible and elastic: it has no smell: its specific gravity is about ,98, or, according to Mr. Davy, ,978; 100

cubic inches of it weighs upwards of 30 grains; it cannot be breathed by animals without instant suffocation; and it is not sensibly absorbed by water. Azote is a constituent part of all animal bodies: it is the cause of the production of Ammonia; and in certain proportions with oxygen, it forms the nitric acid: according to the experiments of Mr. Davy, nitric acid is formed of

29.5 of azote
70.5 of oxygen.

The composition of nitric acid was discovered by Mr. Cavendish, and hence is explained how the putrefaction of animal matters is favourable to the production of nitre. It is from this combination that azote obtained the name of nitrogen, or the base of nitric acid: this, indeed, seems the preferable term, azote only implying the general property of destroying life, which is common to many of the other gases. Azote, in its different stages of oxydation, becomes nitrous oxide, nitrous gas, as well as nitric acid.

In experiments, azote is detected chiefly by its negative properties. Gas may be inferred to be azotic, if it instantly extinguishes a taper immersed in it, and at the same time is not sensibly absorbed by water or liquid alkali; nor renders lime-water turbid; which does not blacken the solutions of lead or silver; which mixes with oxygen in any proportion, without diminution or the production of red fumes; and when so mixed, does not explode by the contact of a lighted body.

AZURE, among painters, the beautiful blue colour, with a greenish cast, prepared from the lapis lazuli, generally called ultramarine. See Colour.

With greater propriety, however, azure signifies that bright blue colour prepared from the lapis amenus, a different stone from the lapis lazuli, though frequently confounded together. This colour is, by our painters, commonly called Lambert's blue.

Azure, in heraldry, the blue colour in the arms of any person below the rank of a baron. In the escutcheon of a nobleman, it is called sapphire; and in that of a sovereign prince, Jupiter. In engraving, this colour is expressed by lines, or strokes drawn horizontally. This colour may signify justice, perseverance, and vigilance; when compounded with

Or.	it signifies.	Cheerfulness
Arg.		Vigilance
Gul.		Readiness
Ver.		Enterprize
Pur.		Goodness
Sab.		Mournfulness.

AZURITE. See Lazulite.

B.

B, The second letter of the alphabet, and first consonant, is formed in the voice by a strong and quick expression of the breath, and opening of the lips, and is therefore one of the labials: as a mute, it hath a middle power between the smooth sound of P, and the rougher sound of F and V.

B is also used as an abbreviation: thus, in music, B stands for the tone above A, as B♭, or ♭B, does for B flat, or the semitone major above A: B also stands for bass, and B. C. for *basso continuo*, or thorough bass. As a numeral, B was used by the Greeks and Hebrews, to denote 2; but among the Romans, for 300, and with a dash over it (thus $\bar{B}$) for 3000.

BABOON, the name of that tribe of apes which have short tails. See Simia.

BABYLONICS, in literary history, a fragment of the ancient history of the world, ending at 267 years before Christ; and composed by Berosus or Berossus, a priest of Babylon, about the time of Alexander. Babylonics are sometimes also cited in ancient writers by the title of Chaldaics. The Babylonics were very consonant with scripture, as Josephus, and the ancient christian chronologers, assure us; whence the author is usually supposed to have consulted the Jewish writings. Berosus speaks of an universal deluge, an ark, &c. He reckons 10 generations between the first man and the deluge, and marks the duration of the several generations by *saroi*, or periods of 223 lunar months; which, reduced to years, differ not much from the chronology of Moses.

The Babylonics consisted of three books, including the history of the ancient Babylonians, Medes, &c. but only a few imperfect extracts are now remaining of the work, preserved chiefly by Josephus and Syncellus; where all the passages of citations of ancient authors out of Berosus are collected with great exactness. Annius, of Viterbo, kindly offered his assistance to supply the loss, and forged a complete Berosus out of his own head. The world has not thanked him for the imposture.

BABYROUSSA, in zoology, the Indian hog. See Sus.

BACCHARIS, in botany, *ploughman spikenard:* of the Syngenesia Polygamia Superflua class and order. Natural order compositæ; compound flowers, division the third discoideæ; corymbiferæ, Jussieu. Essential character; calyx imbricate, cylindric; florets, female mixed with hermaphrodites; down simple; receptacle naked. There are nine species; most of the plants are shrubby; the flowers are disposed commonly in corymbs.

BACHELOR, or Batchelor, a man who still continues in the state of celibacy, or who was never married, and who, in certain cases, is subject to a double tax.

Bachelor was anciently a denomination given to those who had attained to knighthood, but had not a number of vassals sufficient to have their banner carried before them in the field of battle; or, if they were not of the order of bannerets, were not of age to display their own banner, but obliged to march to battle under another's banner. It was also a title given to young cavaliers, who, having made their first campaign, received the military girdle accordingly. And it served to denominate him, who had overcome another in a tournament the first time he ever engaged.

Bachelors, *knights*, were so called, as being the lowest order of knights, or inferior to bannerets.

Bachelors, in an university sense, are persons that have attained to the baccalaureat; or who have taken the first degree in the liberal arts and sciences. Before a person can be admitted to this degree at Oxford, it is necessary that he study there four years; three years more may entitle him to the degree of master of arts; and in seven years more he may commence bachelor of divinity. At Cambridge, the degrees are usually taken much the same as at Oxford, excepting in law and physic, in either of which the bachelors degree may be taken in six years. In France, the degree of bachelor of divinity is attained in five years study, that is, in two years of philosophy, and three of divinity.

Bachelor, in music, one who has taken his first degree in music. A qualification formerly required of a candidate for this honour was, the being able to read and expound certain books in Boethius, a Greek writer in the science, of the sixth century. It is now required of the candidate, to compose an exercise for voices and instruments, in six parts, which exercise must be publicly performed in the music-school, or other place in the university.

BACILLARIA, in natural history, a genus of vermes of the order Infusoria. Generic character: body consisting of cylindrical straw-like filaments, placed parallel to each other, and frequently changing their position. There is but a single species noticed by Gmelin, *viz.* B. paradoxa, found on the ulva latissima; body composed of linear, yellowish, short filaments united together, forming themselves into a square zigzag, or extended line, but always preserving their parallelism and resting in a square.

BACK, in brewing, a large flat vessel, in which the wort is put to stand and cool before boiling. The ingredients of beer pass through three kinds of vessels; they are mashed in one, worked in another, and cooled in a third, called backs, or coolers.

Back *gammon*, an ingenious game played with dice and tables, to be learned only by observation and practice.

However, the following rules concerning it cannot fail to be acceptable to our readers. In the first place, the men, which are thirty in number, being equally divided between the two gamesters, are placed thus, *viz* two on the ace point, five on the side of your left hand-table, three on the cinque, and five on the ace point of our right hand table, which are answered on the like points by your adversary's men: or they may be disposed thus, *viz.* two on the ace point, five on the double sice or sice-cinque point, three on the cinque point in your own tables, and five on the sice point at home; which are to be answered by your adversary.

The men being thus disposed, be sure to make good your trey and ace points; hit boldly, and come away as fast as you can.

When you come to a bearing, have a care of making when you need not; and doublets now will stand you most in stead. If both bear together, he that is first off, without doublets, wins one; if both bear, and one goes off with doublets, he wins two. If your table be clear before your adversary's men are come in, that is backgammon, which is three; but if you thus go off with doublets, it is four.

The great dexterity of this game is, to be forward, if possible, upon safe terms; and so to point the men, that it shall not be possible for the adversary to pass, though you have entered your men, till you give him liberty, after having got two to one of the advantage of the game.

Back *staff*, in the sea language, an instrument formerly used for taking the sun's altitude at sea: so called, because the back of the observer is turned towards the sun during the observation.

Back *stays of a ship*, are ropes belonging to the main-mast and fore-mast, and the masts belonging to them; serving to keep them from pitching forwards or over-board.

BACKING, in law, a warrant of justice of peace, where a warrant granted in one jurisdiction is required to be executed in another; as where a felony has been committed in one county and the offender resides in another; in which case, on proof of the hand-writing of the justice who granted the warrant, a justice in such other county indorses or writes his name at the back of it, thereby giving authority to execute the warrant in such other county

BACON (Roger), in biography, an English monk of the Franciscan order, celebrated for his genius and learning, was born near Ilchester in Somersetshire, in the year 1214. He commenced his studies at Oxford; from whence he removed to the university of Paris, which at that time was esteemed the centre of literature: here he made such progress in the sciences, that he was esteemed the glory of the university, and was in high estimation with several of his countrymen, particularly with Robert Groothead, or Grouthead, afterwards Bishop of Lincoln, his great friend and patron. Having taken the degree of doctor, he took the habit of the Franciscan order, either while he was in France, or soon after his return to England, about the year 1240. He now pursued his favourite study of experimental philosophy with unremitting ardour and assiduity. In this pursuit, in experiments, instruments, and in scarce books, he informs us, he spent, in the course of 20 years, no less than 2000*l.* which sum was generously furnished to him by some of the heads of the university, to enable him the better to pursue his noble researches. But such extraordinary talents, and progress in the sciences, which in that ignorant age were so little known to the rest of mankind, while they raised the admiration of the mere intelligent, could not fail to excite the envy of his illiterate fraternity, whose malice he further drew upon him, by the freedom with which he treated the clergy in his writings, in which he spared neither their ignorance nor their want of morals: these therefore found no difficulty in possessing the vulgar with the notion of Bacon's dealing with the devil. Under this pretence he was restrained from reading lectures; his writings were confined to his convent; and at length, in 1278, he himself was imprisoned in his cell, at 64 years of age. Being allowed, however, the use of his books, he still proceeded in the rational pursuit of knowledge, correcting his former labours, and writing several curious pieces.

When Bacon had been ten years in confinement, Jerom de Ascoli, general of his order, who had condemned his doctrine, was chosen pope, by the name of Nicholas IV.; and being reputed a person of great abilities, and one who had turned his thoughts to philosophical studies, Bacon resolved to apply to him for his discharge; and to shew both the innocence and the usefulness of his studies, addressed to him a treatise, "On the Means of avoiding the infirmities of Old Age." What effect this had on the pope does not appear; it did not at least produce an immediate discharge: however, towards the latter end of his reign, by the interposition of some noblemen, Bacon obtained his liberty; after which he spent the remainder of his life in the college of his order, where he died in the year 1294, at 80 years of age, and was buried in the Franciscan church. Such are the few particulars which the most diligent researches have been able to discover concerning the life of this very extraordinary man.

Bacon's printed works are: 1. "Epistola Fratris Rogeri Baconis de Secretis Operibus Artis et Naturæ, et de Nullitate Magiæ:" Paris, 1542, in 4to. Basil, 1593, in 8vo. 2. "Opus Majus:" London, 1733, in folio, published by Dr. Jebb. 3. "Thesaurus Chemicus:" Francf. 1603 and 1620. These printed works of Bacon contain a considerable number of essays; but there remain also in different libraries several manuscripts not yet published.

His other physical writings shew no less genius and force of mind. In his treatise "Of the Secret works of Art and Nature," he shews that a person, perfectly acquainted with the manner observed by nature in her operations, would be able to rival her. In another piece, "Of the Nullity of Magic," he points out, with great sagacity and penetration, whence the notion of it sprung, and how weak all pretences to it are. From a perusal of his works, it is evident that Bacon was no stranger to many of the capital discoveries of the present and past ages. Gunpowder he certainly knew: thunder and lightning, he tells us, may be produced by art: for that sulphur, nitre, and charcoal, which, when separate, have no sensible effect, when mixed together in due proportion, and closely confined, and fired, yield a loud report. A more precise description of gunpowder cannot be given in words. He also mentions a sort of unextinguishable fire, prepared by art; which proves that he was not unacquainted with phosphorus: and that he had a notion of the rarefaction of the air, and the structure of an air-pump, is past contradiction. He was the miracle, says Dr. Freind, of the age in which he lived, and the greatest genius, perhaps, for mechanical knowledge, that ever appeared in the world since Archimedes. He appears likewise to have been a master in the science of optics: he has accurately described the uses of reading-glasses, and shewn the way of making them. Dr. Freind adds, that he also describes the camera obscura, and all sorts of glasses which magnify or diminish any object, or bring it nearer to the eye, or remove it farther off. Bacon says himself, that he had great numbers of burning-glasses: and that there were none ever in use among the Latins, till his friend Peter de Mahara Curia applied himself to the making of them. That the telescope was not unknown to him, appears from a passage where he says, that he was able to form glasses in such a manner, with respect to our sight and the objects, that the rays shall be refracted and reflected wherever we please, so that we may see a thing under what angle we think proper, either near or at a distance, and be able to read the smallest letters at an incredible distance, and to count the dust and sand, on account of the greatness of the angle under which we see the objects: and also that we shall scarce see the greatest bodies near us, on account of the smallness of the angle under which we view them. His skill in astronomy was amazing: he discovered that error which occasioned the reformation of the calendar; one of the greatest efforts, according to Dr. Jebb, of human industry: and his plan for correcting it was followed by Pope Gregory the Thirteenth, with this variation, that Bacon would have had the correction to begin from the birth of our Saviour, whereas Gregory's amendment reaches no higher than the Nicene council.

On the whole, it cannot be doubted that Friar Bacon is justly entitled to everlasting remembrance, as a philosopher and truly great man. If knowledge, says Dr. Enfield, is now too far advanced for the world to derive much information from his writings, respect must nevertheless be paid to the memory of the man, who knew more than his contemporaries, and who, in a dark age, added new lights to the lamp of science.

Bacon (Francis) in biography, Baron of Verulam, Viscount of St. Albans, and Lord High Chancellor of England under King James I. He was born in 1560, being son of Sir Nicholas Bacon, Lord Keeper of the Great Seal in the reign of Queen Elizabeth, by Ann daughter of sir Anthony Cook, eminent for her skill in the Latin tnd Greek languages. He gave, even in his infancy, tokens of what he would one day become; and Queen Elizabeth had many times occasion to admire his wit and talents, and used to call him her young lord keeper. In his thirteenth year he was entered a student at Trinity College, Cambridge, where he studied the philosophy of Aristotle, and made such progress in his studies, that at sixteen years of age he had run through the whole circle of the liberal arts, as they were then taught, and even began to perceive those imperfections in the existing philosophy, which he afterwards so effectually exposed, and thence not only overturned the tyranny, which prevented the progress of true knowledge, but laid the foundation of that free and useful philosophy, which has since opened a way to so many glorious discoveries. On his leaving the university, his father sent him to France, where, before he was 19 years of age, he wrote a general view of the state of Europe: but Sir Nicholas dying, he was obliged suddenly to return to England, where he applied himself to the study of the common law, at Gray's Inn. His merit at length raised him to the highest dignities in his profession, *viz.* of Attorney-General, and Lord High Chancellor. But being of an easy and liberal disposition, his servants took advantage of that temper, and their situation under him, by accepting presents in the line of his profession. Being abandoned by the king, he was tried by the house of lords for bribery and corruption, and by them sentenced to pay a fine of 40,000*l.* and to remain prisoner in the Tower during the king's pleasure. The king, however, soon after remitted the fine and imprisonment: but his misfortunes had given him a distaste for public affairs, and he afterwards mostly lived a retired life, closely pursuing his philosophical studies and amusements, in which time he composed the greatest part of his English and Latin works. Though even in the midst of his honours and employments he forgot not his philosophy, but in 1620 published his great work "Novum Organum." After some years spent in philosophical retirement, he was suddenly seized with pains in his head and stomach, as he was travelling into the country. These obliged him to stop at Highgate, at the Earl of Arundle's, where he expired, on the 9th of April, in the 66th year of his age. No memorial remains of his last hours, excepting a letter addressed to the nobleman in whose house he died, in which he compares himself to Pliny, who lost his life by approaching too near Vesuvius during an eruption. He was buried at St. Albans.

To Bacon unquestionably belonged a most commanding genius, capable of inventing, methodizing, and carrying forward to considerable maturity, a general plan for the improvement of natural science, by the only sure method of experiment. With a mind prompt in invention, patient in inquiry, and subtle in discrimination, neither affecting nor idolizing antiquity, he formed, and in a great measure executed his great plan, "The Instauration of Sciences," in six parts. Of these the first is entitled "The advancement of Learning:" the second is the "Novum Organum," or new method of employing the reasoning faculties in the pursuit of truth: the "Sylva Sylvarum," or History of Nature, is the third part: the fourth is entitled "Scala Intellectus;" a series of steps is pointed out, by which the understanding may regularly ascend in its philosophical inquiries: the fifth part is "Anticipationes Philosophicæ," intended as philosophical hints and suggestions: the sixth part, in which the universal principles of natural knowledge, drawn from experiments, should be exhibited in a regular and complete system, the author did not attempt to accomplish. The grand edifice, of which he laid the foundation only, he left to be finished by the united labours of philosophers of future ages. With confidence in the merit of his own works, and depending on posthumous celebrity, Bacon begins his last testament with, "My name and memory I leave to foreign nations; and to mine own countrymen, after some time is passed over." Upon the superstructure that has been raised, on the foundation of experimental philosophy he established, will be read by distant ages, "Bacon, the father of experimental philosophy."

Bacon, (John) in biography, a celebrated sculptor, descended from an ancient family in Somersetshire, was born in Southwark, Nov. 24, 1740, where his father Thomas Bacon, a cloth-worker, resided. When very young, Mr. Bacon discovered a great inclination for drawing, common to children; but, not being particularly encouraged in it, he never made much proficiency in the art. At the age of 14, he was bound apprentice to Mr. Crispe, of Bow Church Yard, where he was employed in painting on porcelain. He occasionally assisted in the manufactory of china at Lambeth, particularly in forming small ornamental pieces, which he executed with so much taste, as to indicate no ordinary powers. To his honour be it mentioned, that, by the encouragement he met with, he was able, principally, to support his aged parents, reduced in their circumstances, though by such an exertion he was obliged to abridge himself of the necessaries of life. At the manufactory at Lambeth he had an opportunity of observing models of different sculptors, which were sent to a pottery on the same premises to be burnt. From the sight of these he immediately conceived a strong inclination for his future profession. Having once made his choice, he was unremitting in his diligence; and it is said that his progress was as rapid as his turn was sudden and unpremeditated. During this young man's apprenticeship, he formed a design of making statues in artificial stone; and to his exertions is to be attributed the flourishing state of Coades's manufactory. In 1763, Mr. Bacon attempted to work in marble, and having never seen the operation performed, he was led to invent an instrument for transferring the form of the model to the marble, this is called "getting out the points," which has been brought into use both in England and on the continent. The advantage of this instrument consists in its certainty and exactness, in its taking a correct measurement in every direction, in its occupying a small compass, and that it may be transferred either to the model or the marble, without a separate instrument for each. In 1768, Mr. Bacon removed to the West end of the town and attended upon the Royal Academy, where he received his first instructions, having never before seen the art of modelling or sculpture regularly performed. In the following year the gold medal for sculpture, the first ever given by the society, was voted to Mr Bacon. He became an associate of that body in the year 1770, and from this time his reputation was firmly established, and he obtained patronage of the highest rank. It would be needless to attempt an enumeration of the various works by which he attained to the first eminence in a very difficult profession. The efforts of his genius are widely spread, and his name will long live, the pride of the country which gave him birth, and from which he had never occasion to travel for the improvement of his talents, or the cultivation of a fine taste.

This distinguished artist was suddenly attacked with an inflammation in his bowels on the 4th of August, 1799, which terminated his life in little more than two days. He died August 7th, in the 59th year of his age, leaving behind him a character as great for integrity and virtue, as he had obtained in his profession as a sculptor. He had been twice married, and left ten children and a widow, to mourn the loss of a tender father and affectionate husband. Cecil's Memoirs of Bacon.

BACOPA, in botany, a genus of the Pentandria Monogynia class and order. Natural order Succulentæ: portulaceæ Jussieu. Essential character: corolla with a short tube spreading at top; stem inserted into the tube of the corolla; stigma headed; capsule one-celled. There is but one species: *viz.* the B. aquatica, which is a native of Cayenne, on the borders of rivulets, flowering and bearing fruit in December. The French call it *herbe-aux-brulures*, on account of its efficacy in curing burns.

BACTRIS, in botany, a genus of plants of the Monoecia Hexandria class and order. Natural order of palms. Essential character: male, calyx three-parted; corolla one-petalled, three-cleft; stamina six. Female, calyx one-leaved, three-toothed; corolla one-petalled, three-toothed; stigma obscurely three-cleft; drupe coriaceous. There are two species, the minor and major, natives of Carthagena in South-America.

BADGE, in naval architecture, an ornament placed on the outside of small ships, very near the stern, containing either a window, or the representation of one.

BÆCKIA, in botany, so named in honour of Abraham Baeck, the intimate friend of Linnæus, who received this plant from him; of the Octandria Monogynia class and order. Natural order Calycanthemæ: Onagree Jussieu. Essential character; calyx funnel-form, five-toothed; corolla five-petalled; capsule globular, four-celled, crowned. There is one species, *viz.* B. frutescens, a shrub which has the habit of southernwood, with wand-like branches, and opposite short simple twigs. It is a native of China, and called their tiongina.

BÆOBOTRYS, in botany, of the Pentandria Monogynia class and order. Essential character: corolla tubular, with a five-cleft border: calyx double; outer two-leaved; inner one-leafed, bell-shaped; berry globose, one-celled, growing to the calyx; many seeded. A single species, *viz.* the B. memoralis, native of the Isle of Tanna in the South Seas.

BAGGAGE, in military affairs, denotes the clothes, tents, utensils of divers sorts, provisions, and other necessaries belonging to an army.

Before a march, the waggons with the baggage are marshalled according to the rank which the several regiments bear in the army; being sometimes ordered to follow the respective columns of the army, sometimes to follow the artillery, and sometimes to form a column by themselves. The general's baggage marches first; and each waggon has a flag shewing the regiment to which it belongs.

BAGPIPE, a musical instrument of the wind kind, chiefly used in country places, especially in the north: it consists of two principal parts; the first a leathern bag, which blows up like a foot-ball by means of a port-vent or little tube fitted to it, and stopped by a valve; the other part consists of three pipes or flutes, the first called the great pipe or drone, and the second the little one, which pass the wind out only at the bottom; the third has a reed, and is played on by compressing the bag under the arm, when full, and opening or stopping the holes, which are eight, with the fingers. The little pipe is ordinarily a foot long: that played on thirteen inches; and the port-vent six.

This instrument has been so long a favourite with the natives of Scotland, that it may be considered as a national instrument. It is not known when it was introduced there, but it has been conjectured that the Danes or Norwegians carried it into the Hebrides, where it has been known from times immemorial.

BAGS, *sand*, in military affairs, filled with earth or sand, to repair breaches, and the embrasures of batteries, when damaged by the enemies fire, or by the blast of the guns; they are also used to raise a parapet in haste, or to repair one that is beaten down. They are only used when the ground is rocky, and does not afford earth enough to carry on the approaches.

BAHAR, or **Barre**, in commerce, weights used in several places in the East Indies.

There are two of these weights, the one the great bahar, with which they weigh pepper, cloves, nutmegs, ginger, &c. and contains five hundred and fifty pounds of Portugal, or about five hundred and twenty-four pounds nine ounces avoirdupois weight. With the little bahar they weigh quicksilver, vermilion, ivory, silk, &c. It contains about four hundred and thirty-seven pounds nine ounces avoirdupois weight.

BAIL, in law, the setting at liberty one arrested or imprisoned, upon an action, either civil or criminal, upon sureties taken for his appearance, at a day and place assigned; and is either common or special.

Common bail is in actions of small prejudice or slight proof, in which case any sureties are taken. But if the plaintiff make affidavit that the cause of action amounts to 10*l.* or upwards, in order to arrest the defendant, and make him put in substantial sureties for his appearance, called special bail, it is then required that the true cause of action be expressed in the body of the writ.

Special bail, are two or more persons, who, after arrest, undertake generally, or enter into bond to the sheriff in a certain sum to insure the defendant's appearance at the return of the writ: this obligation is called bail-bound.

In criminal cases, all persons, by the common law, might be bailed till they were convicted of the offence laid to their charge; the statutes have made many exceptions to this rule: when these do not intervene, bail may, upon offering sufficient surety, be taken either in court or, in particular cases, by the sheriff, coroner, or other magistrate, but usually by justices of peace, in the following cases; persons of good fame, charged with the suspicion of man-slaughter or other inferior homicide. Persons charged with petit larceny, or any felony not before specified. Accessaries to felony, not being of evil fame, nor under strong presumption of guilt. Bail cannot be taken upon an accusation of treason, nor murder, nor in the case of man-slaughter, if the person be clearly the slayer; nor does it extend to such as being committed for felony have broken prison, nor to persons out-lawed, nor to those who have abjured the realm, nor approvers, nor persons taken in the fact of felony, nor persons charged with house-burning, nor persons taken by writ of *excommunicato capiendo.*

BAILE, or **Bale**, in the sea language. The seamen call throwing the water by hand out of the ship or boat's hold bailing. They also call those hoops that bear up the tilt of a boat its bails.

BAILLY (**Jean Sylvain**), a celebrated French astronomer, historiographer, and politician, was born at Paris the 15th of September 1736, and has figured as one of the greatest men of the age, being a member of several academies, and an excellent scholar and writer. He enjoyed for several years the office of keeper of the king's pictures at Paris. He published in 1766, a volume in 4to, "An Essay on the Theory of Jupiter's Satellites," preceded by a history of the astronomy of these satellites. In the "Journal Encyclopédique," for May and June 1773, he addressed a letter to M. Bernoulli, astronomer royal at Berlin, upon some discoveries relative to these satellites which he had disputed. In 1768, he published the Eulogy of Leibnitz, which obtained the prize at the Academy of Berlin,. where it was printed. In 1770, he printed at Paris, in 8vo. the Eulogies of Charles the Vth, of De la Caille, of Leibnitz, and of Corneille. This last had the second prize at the Academy of Rouen, and that of Moliere had the same honour at the French Academy.

M. Bailly was admitted into the Academy as adjunct, the 29th of January, 1763, and as associate, the 14th of July, 1770.—In 1775 came out at Paris, in 4to, his "History of the Ancient Astronomy," in one volume; in 1779, the "History of Modern Astronomy," in two volumes; and in 1787, the "History of the Indian and Oriental Astronomy," being the second volume of the Ancient Astronomy Besides these, he was author of many memoirs in the several volumes of the Academy.

In the beginning of the revolution in France, in 1789, M. Bailly took an active part in that business, and was so popular and generally esteemed, that he was chosen the first president of the states general, and of the national assembly, and was afterwards, for two years together, the mayor of Paris; in both which offices he conducted himself with great spirit, and gave general satisfaction.

He soon afterward, however, experienced a sad reverse of fortune; being accused by the ruling party of favouring the king, he was arrested, and summarily condemned by an infamous and bloody tribunal, for incivism and wishing to overturn the republic, and died by the guillotine, at Paris, on the 11th day of November, 1793, at 57 years of age. The character of this great man can only be estimated by his works. In his person he was tall; his deportment was grave and sedate, and he blended firmness with sensibility.

BAILIFF, an officer appointed for the administration of justice within a certain district called a bailiwick. Hence the sheriff is considered a bailiff to the crown; and his court, of which he has the care, and in which he is to execute the king's writ, is called his bailiwick, so also his officers, who execute writs, warrants, &c. are called bailiffs.

Bailiffs *of franchises*, those appointed by every lord within his liberty, to do such offices therein as the bailiff errant does at large in the county.

There are also bailiffs of forests, and bailiffs of manors, who direct husbandry, fell trees, gather rents, pay quit rents, &c.

Bailiff, *water*, an officer appointed in all port-towns for the searching of ships, gathering the toll for anchorage, &c. and arresting persons for debt, &c. on the water.

Bailiff, however, is still applied to the chief magistrate of several corporate towns. The government of some of the king's castles is also committed to persons called bailiffs, as the bailiff of Dover castle.

BAILIWICK, that liberty which is exempted from the sheriff of the county, over which liberty the lord thereof appoints his own bailiff, with the like power within his precinct as an under-sheriff exercises under the sheriff of the county: or it signifies the precinct of a bailiff, or the place within which his jurisdiction is terminated: such is the bailiff of Westminster.

BAILMENT, is the delivery of things to another, sometimes to be delivered back to the bailer, sometimes to the bailee, and sometimes to a third person: this delivery is called a bailment. The following rules are binding in the law of bailments: a bailee, who derives no advantage for his undertaking, is responsible only for gross negligence. A bailer, who alone receives benefit from the bailment, is responsible for slight neglect. When the bailment is beneficial to both parties, the bailee must be answerable for ordinary neglect. No bailee shall be charged for a loss by inevitable accident, or irresistible force, except by special agreement. Robbery by force is considered as irresistible, but a loss by private stealth is presumptive evidence of ordinary neglect.

BAINBRIDGE, (John) an eminent physician, astronomer, and mathematician. He was born in 1582, at Ashby de la Zouch, Leicestershire. He studied at Cambridge, where, having taken his degrees of bachelor and master of arts, he returned to Leicestershire, kept a grammar school, and at the same time practised physic, employing his leisure hours in studying mathematics, especially astronomy, which had been his favourite science from his earliest years. By the advice of his friends, he removed to London, to better his condition, and improve himself with the conversation of learned men there; and here he was admitted a fellow of the College of Physicians. His description of the comet, which appeared in 1618, greatly raised his character, and procured him the acquaintance of Sir Henry Savile, who, in 1619, appointed him his first professor of astronomy at Oxford. On his removal to this university, he entered a master commoner of Merton College; the master and fellows of which appointed him junior reader of Linacer's lecture in 1631, and superior reader in 1635. As he resolved to publish correct editions of the ancient astronomers, agreeably to the statutes of the founder of his professorship, that he might acquaint himself with the discoveries of the Arabian astronomers, he began the study of the Arabic language when he was above 40 years of age. Before he had completed that work he died, in the year 1643, at 61 years of age.

Dr. Bainbridge wrote many works, but most of them have never been published; those that were published, were the three following: viz. 1. "An Astronomical Description of the late Comet, from the 18th of November, 1618, to the 16th of December following;" 4to, London, 1619. 2. "Procli Sphæra, Ptolomæi de Hypothesibus Planetarum Liber singularis." To which he added Ptolomy's "Canon Regnorum." He collated these pieces, with ancient manuscripts, and gave a Latin version of them, illustrated with figures, printed in 4to, 1620. 3. "Canicularia." A treatise concerning the Dog-star, and the canicular days; published at Oxford, in 1648, by Mr. Greaves, together with a demonstration of the heliacal rising of Sirius, the Dog-star, for the parallel of Lower Egypt. Dr. Bainbridge undertook this work at the request of Archbishop Usher, but he left it imperfect; being prevented by the breaking out of the civil war, or by death.

There were also several dissertations of his prepared for, and committed to the press the year after his death, but the edition of them was never completed.

BAIT, in fishing, a thing prepared to take and bring fishes to. See Angling.

BAITING is applied to the act of smaller or weaker beasts attacking and harrassing greater and stronger ones. Bulls and bears are baited by mastiffs, or bull-dogs. The practice of bull-baiting, and other sports of the same kind, which cannot be too strongly reprobated, may be traced to an early period of our history. In the twelfth century, it was a common practice on every holiday. In the reign of Henry VIII. many herds of bears were maintained for the purpose of baiting. Queen Mary had a great exhibition of bear-baiting immediately after mass, with which to entertain her sister Elizabeth, then a prisoner in Hatfield-house; and the same princess, soon after her accession to the throne, entertained the foreign ambassadors with the baiting of bulls and bears. The custom of bull-baiting was most ingeniously defended by Mr. Windham, in the house of Commons, in the session of 1803, when a bill was brought in to stop that inhuman practice. Whales are baited by a kind of fish called oriæ, or killers, ten or twelve of which will attack a young whale at once, and not leave him till he is killed.

BAKER, (Thomas) a mathematician of some eminence, was born at Ilton, in Somersetshire, in 1625. He entered upon his studies at Oxford, in 1640, where he remained seven years. He was afterwards appointed vicar of Bishop's-Nymmet in Devonshire, where he lived a studious and retired life for many years, chiefly pursuing the mathematical sciences; of which he gave a proof of his critical knowledge, in the book he published, concerning the general construction of biquadratic equations, by a parabola and a circle; the title of which book at full length is, "The Geometrical Key; or the Gate of Equations unlocked: or a new Discovery of the construction of all Equations, howsoever affected, not exceeding the fourth degree; *viz.* of Linears, Quadratics, Cubics, Biquadratics, and the finding of all their roots."

A little before his death, the Royal Society sent him some mathematical queries; to which he returned such satisfactory answers, as procured the present of a medal, with an inscription full of honour and respect. Mr. Baker died at Bishop's-Nymmet, 1690, in the 65th year of his age.

BAKER, (Henry) an ingenious and diligent naturalist, was born in London about the beginning of the 18th century. He was brought up under an eminent bookseller, but being of a philosophical turn of mind, he quitted that line of business soon after the expiration of his apprenticeship, and took to the employment of teaching deaf and dumb persons to speak and write, &c. in which occupation, in the course of his life, he acquired a handsome fortune. For his amusement, he cultivated various natural and philosophical sciences, particularly botany, natural history, and microscopical subjects, in which he especially excelled, having, in the year 1744, obtained the Royal Society's gold medal, for his microscopical experiments on the crystallizations and configurations of saline particles. He published various papers in the Transactions of the Royal Society, of which he was a worthy member, as well as of the Society of Antiquaries.

He was author of many pieces on various subjects, the principal of which were, his Treatise on the Water Polype, and two treatises on the Microscope; *viz.* "The Microscope made easy," and "Employment for the Microscope," which have gone through several editions.

Mr. Baker married Sophia, youngest daughter of the celebrated Daniel Defoe, by whom he had two sons, who both died before him. He terminated an honourable and useful life, at his apartments in the Strand, on the 25th of November, 1774, being then upwards of 70 years of age.

Baker, a person whose occupation or business is to prepare bread, or to reduce meal of any kind, whether simple or compound, into bread, biscuit, &c. It is not known when this very useful business first became a particular profession. Bakers were a distinct body of people in Rome, nearly two hundred years before the christian æra, and it is supposed that they came from Greece. To these were added a number of freemen, who were incorporated into a college, from which neither they nor their children were allowed to withdraw. They held their effects in common, without enjoying any power of parting with them. Each bakehouse had a patron, who had the superintendency of it; and one of the patrons had the management of the others, and the care of the college. So respectable were the bakers at Rome, that occasionally one of the body was admitted among the senators. Even by our own statutes, the bakers are declared not to be handicrafts; and in London they are under the particular jurisdiction of the lord mayor and aldermen, who fix the price of bread, and have the power of fining those who do not conform to their rules. Bread is made of flour, mixed and kneaded with yeast, water, and a little salt. It is known in London under two names, the white or wheaten, and the household: these differ only in degrees of purity: and the loaves must be marked with a W or H, or the baker is liable to suffer a penalty. The process of bread-making is thus described: to a peck of meal, are added a handful of salt, a pint of yeast, and three quarts of water, cold in summer, hot in winter, and temperate between the two. The whole being kneaded, will rise in about an hour; it is then moulded into loaves, and put into the oven to bake. The oven takes more than an hour to heat properly, and bread about three hours to bake. The price of bread is regulated according to the price of wheat; and bakers are directed in this by the magistrates, whose rules they are bound to follow. By these, the peck-loaf of each sort of bread must weigh seventeen pounds six ounces avoirdupois weight, and smaller loaves in the same proportion. Every sack of flour is to weigh two hundred and a half; and from this there ought to be made, at an average, twenty such peck loaves, or eighty common quartern loaves. If the bread was short in its weight only one ounce in thirty-six, the baker formerly was liable to be put in the pillory; and for the same offence he may now be fined, at the will of the magistrates, in any sum not less than one shilling, or more than five shillings for every ounce wanting; such bread being complained of, and weighed, in the presence of the magistrate, within twenty-four hours after it is baked, because bread loses in weight by keeping. It is said that scarcely any nation lives without bread, or something as a substitute for it. The Laplanders have no corn, but they make bread of their dried fishes, and of the inner rind of the pine, which seems to be used not so much on account of the nourishment to be obtained from it, as for the sake of having a dry food. In Norway they make bread that will keep thirty or forty years, and the inhabitants esteem the old and stale bread in preference to that which is newly made. For their great feasts particular care is taken to have the oldest bread; so that at the christening of a child, for instance, they have usually bread which has been baked perhaps at the birth of the father, or even grandfather. It is made from barley and oats, and baked between two hollow stones. See Biscuit.

BALÆNA, the whale, in zoology, a genus of the Mammalia class, belonging to the order of Cete. The characters of this genus are these: the balæna, in place of teeth, has a horny plate on the upper jaw, and a double fistula or pipe for throwing out water. There are six species: Balæna bo-ops, the pike-headed whale, has a double pipe in its snout, three fins and a hard horny ridge on its back. The belly is full of longitudinal folds or rugæ. It frequents the northern ocean. The length of one taken on the coast of Scotland, as remarked by Sir Robert Sibbald, was forty six feet, and its greatest circumference twenty. This species takes its name from the shape of its nose, which is narrower and sharper pointed than that of other whales. One was taken a few years since near Reedy Island in the Delaware river, and was exhibited in Philadelphia. Balæna musculus has a double pipe in its front, and three fins; the under jaw is much wider than the upper one. It frequents the Scotch coasts, and feeds upon herrings. Balæna mysticetus, the common or great Greenland whale, which has no fin on the back. This is the largest of all animals; it is even at present sometimes found in the northern seas ninety feet in length; but formerly they were taken of a much greater size, when the captures were less frequent, and the fish had time to grow. Such is their bulk within the arctic circle; but in the torrid zone, where they are less molested, whales are still seen one hundred and sixty feet long. The head is very much disproportioned to the size of the body, being one-third of the size of the fish; the under lip is much broader than the upper. The tongue is composed of a very soft spongy fat, capable of yielding five or six barrels of oil. The gullet is very small for so vast a fish, not exceeding four inches in width. In the middle of the head are two orifices, through which it spouts water to a vast height, and with a great noise, especially when disturbed or wounded; the eyes are placed towards the back of the head, being the most convenient situation for enabling them to see both before and behind; as also to see over them, where their food is principally found. They are guarded by eye-lids and eye-lashes, as in quadrupeds; and the animals seem to be very sharp-sighted. Nor is their sense of hearing in less perfection; for they are warned at a great distance of any danger preparing against them. It is true, indeed, that the external organ of hearing is not perceptible, for this might only embarrass them in their natural element; but as soon as the thin scarff skin is removed, a black spot is discovered behind the eye, and under that is the auditory canal that leads to a regular apparatus for hearing. In short, the animal hears the smallest sounds at very great distances, and at all times, except when it is spouting water, which is the time that the fishers approach to strike it. What is called whalebone, adheres to the upper jaw, and is formed of thin parallel laminæ, some of the longest four yards in length; of these there are commonly 350 on each side, but in very old fish more. They breed only once in two years. Their fidelity to each other exceeds whatever we are told even of the constancy of birds. Some fishers, as Anderson informs us, having struck one of two whales, a male and a female, that were in company together, the wounded fish made a long and terrible resistance; it struck down a boat with three men in it, with a single blow of its tail, by which all went to the bottom. The other still attended its companion, and lent it every assistance; till at last, the fish that was struck sunk under the number of its wounds; while its faithful associate, disdaining to survive the loss, with great bellowing, stretched itself upon the dead fish, and shared its fate. The whale goes with young nine or ten months, and is then fatter than usual, particularly when near the time of bringing forth. It is said that the embryo, when first perceptible, is about seventeen inches long, and white; but the cub, when excluded, is black, and about ten feet long. She generally produces one young one, and never above two. When she suckles her young, she throws herself on one side on the surface of the sea, and the young one attaches itself to the teat. Nothing can exceed the tenderness of the female for her offspring. Even when wounded, she still clasps her young one; and when she plunges to avoid danger, takes it to the bottom; but rises sooner than usual, to give it breath again. The young ones continue at the breast for a year, during which time they are called, by the sailors, short-heads. They are then extremely fat, and yield above fifty barrels of blubber. The mother at the same time is equally lean and emaciated. In the year 1814, one of this species was killed, that had made its way up the Delaware river, and grounded in shoal water near the falls; it proved to be a young one, and was exhibited in Philadelphia. Balæna physalus, or fin fish, is distinguished from the common whale by a fin on the back, placed very low and near the tail. The length is equal to that of the common kind, but much more slender. It is furnished with whalebone in the upper jaw, mixed with hairs, but short and knotty, and of little value. The blubber also in the body of this kind is very inconsiderable. These circumstances, added to its extreme fierceness and agility, which render the capture very dangerous, cause the fishers to neglect it. The natives of Greenland, however, hold it in great esteem, as it affords a quantity of flesh, which, to their palate, is very agreeable. The lips are brown, and like a twisted rope; the spout hole is seemingly split in the top of its head, through which it blows water with much more violence, and to a greater height, than the common whale. The fishers are not very fond of seeing it, for on its appearance the others retire out of those seas. It feeds on herring and small fish. Inoffensive as the whale is, it is not without enemies. There is a small animal of the shell-fish kind, called the whale-louse, that sticks to its body, as we see shells sticking to the foul bottom of a ship. This insinuates itself chiefly under the fins; and whatever efforts the great animal makes, it still keeps its hold, and lives upon the fat, which it is provided with instruments to arrive at. The sword-fish, however, is the whale's most terrible enemy. At the sight of this little animal, the whale seems agitated in an extraordinary manner, leaping from the water as if with affright: wherever it appears, the whale perceives it at a distance, and flies from it in the opposite direction. The whale has no instrument of defence, except the tail; with that it endeavours to strike the enemy; and a single blow taking place would effectually destroy its adversary; but the sword-fish is as active as the other is strong, and easily avoids the stroke; then bounding into the air, it falls upon its enemy, and endeavours not to pierce with its pointed beak, but to cut with its toothed edges. The sea all about is soon dyed with blood, proceeding from the wounds of the whale; while the enormous animal vainly endeavours to reach its invader, and strikes with its tail against the surface of the water, making a report at each blow louder than the noise of a cannon. There is still another powerful enemy to this fish, which is called the oria, or killer. A number of these are said to surround the whale in the same manner as dogs get round a bull. Some attack it with their their teeth behind; others attempt it before: until at last the great animal is torn down, and its tongue is said to be the only part they devour when they have made it their prey. But of all the enemies of these enormous fishes, man is the greatest; he alone destroys more in a year than the rest in an age, and actually has thinned their numbers in that part of the world where they are chiefly sought. At the first discovery of Greenland, whales, not being used to be disturbed frequently, came into the very bays, and were accordingly killed almost close to the shore; so that the blubber, being cut off, was immediately boiled into oil on the spot. The ships, in those times, took in nothing but the pure oil and the whale-bone, and all the business was executed in the country; by which means a ship could bring home the product of many more whales, than she can according to the present method of conducting this trade. The fishing also was then so plentiful, that they were obliged sometimes to send other ships to fetch off the oil they had made, the quantity being more than the fishing ships could bring away. But time and change of circumstances have shifted the situation of this trade. The ships coming in such numbers from Holland, Denmark, Hamburg, and other northern countries, all intruders upon the English, who were the first discoverers of Greenland, the whales were disturbed; and gradually, as other fish often do, forsaking the place, were not to be killed so near the shore as before; but are now found, and have been so ever since, in the openings and space among the ice, where they have deep water, and where they go sometimes a great many leagues from the shore. The whale-fishery begins in May, and continues all June and July; but whether the ships have good or bad success, they must come away, and get clear of the ice, by the end of August. There are several whale-fisheries on the coast of the United States, and two or three of these animals are taken annually as far south as Great Egg Harbour. See Plate I. PISCES, fig. 5. WHALE FISHERY.

BALE, in commerce, is said of merchandizes packed up in cloth, and corded round very tight, in order to keep them from breaking, or preserve them from the weather. Most of the merchandize capable of this kind of package, designed for fairs or exportation, ought to be in bales, and too much care cannot be taken in packing them, to prevent their being damaged. The bales are always to be marked and numbered, that the merchants to whom they belong may easily know them.

BALE *goods*, among the English merchants, are all such as are imported or exported in bales; but the French give that name to certain hardwares, and other sort of merchandise, which come to Paris, and are commonly made by bad workmen, of indifferent materials.

BALISTES, in natural history, a genus of Branchiostegous fishes. The generic characters are: teeth eight in each jaw, of which the two anterior ones are longer, and three lateral ones on each side more obtuse; body compressed; abdomen carinated; skin tough, often reticulated by scale-like divisions. There are 24 species; of which we shall mention the following, *viz* the B. monoceros, or unicorn file-fish, which is often two feet long or more; the body is of an oval shape, and possesses the power of inflating at pleasure the sides of the abdomen, by means of a pair of bony processes within that part; the skin is every where covered with minute spines, and the general colour is grey, inclining to brown on the upper parts, and varied with irregular, dusky, subtransverse, undulations and spots: immediately over the head, just above their eyes, is a strong, single, recurved spine, of considerable length, and serrated on the hind part: both fins and tail are of a pale brown colour, the latter being marked by a few dusky bars. This fish is a native of the Indian and American seas, feeding chiefly on crustaceous and testaceous marine animals. It is said to be a poisonous fish. B. vetula, or ancient file-fish, is likewise denominated the old wife fish, a name which it is supposed to have obtained from the appearance of the mouth when viewed in front, as well as from the slightly murmuring noise which it utters when first taken. B. maculatus, spotted file-fish, is of an oval shape; its length is about eighteen or twenty inches, sometimes as much as two feet; colour pale violet; skin strongly marked into lozenge-shaped reticulations; first dorsal fin three-rayed; the first very strong; ventral spines rough, and but slightly projecting; tail somewhat convex in the midlle of the outline, with falcated tops; whole body dorsal, and anal fin marked with numerous round blue spots. Native of the Indian and American seas. B. undulatus, or black file-fish, is a native of the Indian seas, observed first about the shores of Sumatra by the enterprizing and highly meritorious traveller Mungo Park. From the mouth to the base of the pectoral fins run three red lines, and the body is obliquely undulated by twelve lines of the same colour. Some fish of this genus are called Trigger-fish, from the circumstance of the first ray of the dorsal fin being fixed by the second, when elevated to a perpendicular position, like the trigger of a gun; this ray cannot be restored to its oblique position without first inclining the second ray, which by a peculiar mechanism, acts as a prop. See Plate II. Pisces, fig. 1.

BALL, in the military art, comprehends all sorts of bullets for fire-arms, from the cannon to the pistol.

Cannon-balls are made of iron; musket-balls, pistol-balls, &c. are of lead. The experiment has been tried of iron balls for pistols and fusees, but they are justly rejected, not only on acccount of their lightness, which prevents them from flying straight, but because they are apt to furrow the barrel of the pistol, &c.

Cannon-balls are always distinguished by their respective calibres: thus,

For a pound ball	the diameter is
42	6.68
32	6.10
24	5.54
18	5.04
12	4.40
9	4.00
6	3.49
3	2.77
2	2.42
1	1.92

Ball *and socket* is an instrument made of brass, with a perpetual screw, so as to move horizontally, vertically, and obliquely; and is generally used for the managing of surveying instruments, and astronomical instruments.

BALLAD, in music, formerly a little history told in verse, and sung to the harp or viol, either by the author himself, or the jongleur, whose profession it was to follow the bard and sing his works. About a century since the word ballad began to imply a brief, simple tale, conveyed in three or four verses, set to a short and familiar air, in which sense it is now understood.

BALLANCE, or **Balance**, in mechanics, one of the simple powers, which serves to find out the equality or difference of weight in heavy bodies. See Mechanics.

Ballance *of trade*, a term applied to the money balance to be paid by one nation trading and carrying on business with another. So far as the articles mutually exported and imported pay for each other, there is no ballance; but on which ever side the exports fall short in their amount, that nation is said to have the ballance of trade against it. See Trade.

Ballance, *hydrostatical.* See Hydrostatics.

Ballance *of a clock or watch.* See Clock-work and Watch-work.

Ballance, *to*, in sea-language, to contract a sail into a narrower compass, and the term is applied particularly to the mizen of a ship, and the main sail of those vessels in which it is extended by a boom. The operation of balancing the mizen is performed by lowering the yard a little, then rolling up a small portion of the sail at the upper corner, and lashing it about one-fifth down towards the mast. A boom-sail is ballanced by rolling up a portion of the clue, or lower aftermost corner, and fastening it strongly to the boom.

BALLAST, a quantity of stones, gravel, or sand, laid in a ship's hold, to make her sink to a certain depth into the water, and sail upright, rendering her of a prodigious weight. The ballast is sometimes one-quarter, one-third, or one half, according to the difference of the bulk of the ship. Flat vessels require the most ballast. Ships are said to be in ballast, when they have no other loading. Masters of vessels are obliged to declare the quantity of ballast they bear, and to unload it at certain places. They are prohibited unloading their ballast in havens, roads, &c. the neglect of which prohibition has ruined many excellent ports. All ships and vessels taking in ballast on the river Thames are bound to pay the corporation of the Trinity-house, for every ton carried to any ship in the coal trade, 1*s.* and for every other British ship, 1*s.* 3*d.* For every ton carried to any foreign ship, 1*s.* 7*d.* The Trinity-house employ men, and regulate them, and their lighters are to be marked. The art of ballasting, as it is called, consists in placing the centre of gravity, so as neither to be too high nor too low, too far forward nor too far aft, and that the surface of the water may nearly rise to the extreme breadth amidship, and thus the ship will be enabled to carry a good sail, incline but little, and ply well to the windward.

BALLET, in music, a theatrical representation of some tale or fable told in dance, or metrical action, accommpanied with music. The artist who invents and superintends the rehearsal and performance of the ballet, is called the ballet-master.

BALLISTA, in antiquity, a military machine, used by the ancients in besieging cities, to throw large stones, darts, and javelins.

It resembled our cross-bows, though much larger, and superior in force.

From this engine stones of a size not less than mill-stones were thrown with so great a violence, as to dash whole houses in pieces at a blow. It is described thus: a round iron cylinder was fastened between two planks, from which reached a hollow square beam, placed crosswise, and fastened with cords, to which were added screws; at one end of this stood the engineer, who put a wooden shaft with a big head into the cavity of the beam: this done, two men bent the engine by drawing some wheels: when the top of the head was drawn to the utmost end of the cords, the shaft was driven out of the ballista, &c.

BALLOON, or **Balon**, in a general sense, signifies any spherical hollow body, of whatever matter it be composed, or for whatever purposes it be designed.

Thus, with chemists, balloon denotes a round short-necked vessel, used to receive what is distilled by means of fire; in architecture, a round globe on the top of a pillar; and among engineers, a kind of bomb made of pasteboard, and played off in fire-works, either in the air or in the water, in imitation of a real bomb. Balloon, in the French paper trade, is a term for a quantity of paper, containing 24 reams. It is also the name of a sort of brigantine used in the kingdon of Siam.

Balloon. See Aerostation.

BALLOTA, in botany, a genus of the Didynamia Gymnospermia class and order. Natural order of the Verticillatæ, or Labiatæ. Essential character: calyx salver-shaped, five-toothed, ten-streaked: corolla upper-lip crenate, concave. There are six species. B. nigra is the black or stinking horehound, a hairy plant, with an upright brownish stem, about two feet in height. It is a perennial plant, common in most parts of Europe, in waste places and hedges, flowering in July. It is recommended in hysterical cases. In Gothland it is an universal remedy for cattle; but the Swedish plant is probably not the same as ours. The European sorts, being common stinking weeds, are never introduced into gardens.

BALLS, or **Ballets**, in heraldry, a frequent bearing in coats of arms, usually denominated, according to their colours, bezants, plates, hurts, &c.

BALM, or **Baum**, in botany. See Melissa.

BALNEUM, a term used by chemists to signify a vessel filled with some matter, as sand, water, or the like, in which another is placed that requires a more gentle heat than the naked fire.

BALSAM, or **Native Balsam**, an oily, resinous, liquid substance, flowing either spontaneously, or by means of incision, from certain plants of sovereign virtue in the cure of several disorders.

The term balsam, or balm, was originally confined to a thick fragant juice, obtained from the amyris Gileadénsis, and afterwards applied by chemists to all substances which possessed the same degree of consistence and a strong smell, whether natural or artificial. The word balsam originally implied a substance possessing a certain degree of fluidity: but now there are two classes of balsams; the one fluid, and the other solid and brittle. A balsam, then, is a substance, which possesses the general properties of a resin; but which, when heated or digested in acids, yields a portion of benzoic acid. See Benzoin.

Chemists, in general, have considered them as combinations of a resin with benzoic acid; but Mr. Hatchet has made it probable, that the acid is formed at the time of its separation. They are insoluble in water; but when boiled in that liquid, often give out a portion of benzoic acid. Alcohol and ether dissolve them readily. The strong acids, likewise, dissolve them, and during the solution a portion of benzoic acid is separated. Nitric acid, in some cases, evolves likewise traces of prussic acid. The alkalies act upon them nearly as on the resins. They may be divided into two classes; namely, liquid and solid balsams.

Liquid balsams. The liquid balsams at present known are five in number; namely,

1. Opobalsamum.
2. Copaiva.
3. Tolu.
4. Peru.
5. Styrax.

1. Opobalsamum, or balm of Gilead.—This balsam is obtained from the amyris Gileadensis, a tree which grows in Arabia, especially near Mecca. It is so much valued by the Turks, that it is seldom or never imported into Europe. We are, of course, ignorant of its composition. It is said to be at first turbid and white, and of a strong aromatic smell, and bitter, acrid, astringent taste; but by keeping it becomes limpid and thin, and its colour changes first to green, then to yellow, and at last it assumes the colour of honey, and the consistence of turpentine. It is also very tenacious and glutinous, sticking to the fingers, and may be drawn into long threads. The mode of ascertaining the purity of this balsam at Cairo and Mecca is, to drop it into a cup of clear cold water; if it remain in one place on the surface, it is of little or no value, but if it extend itself like a skin over the whole surface, (and this skin is even, and almost transparent, and may be taken off the water with a hair,) it is of great worth. The balsam of Gilead principally comes from Arabia Petræa, from whence the Arabs carry it to Mecca for sale, during the stay of the caravans from Egypt and Turkey. It grows also in the Holy Land, but not without much culture and attention, whereas in Arabia it grows without cultivation. It is the produce of a species of the amyris, rising to the height of the pomegranate tree, to which it has a great resemblance, both in its branches and flowers. See Amyris. The balsam is obtained by incision during the summer months, flowing over in a viscous juice, called Opobalsamum. It is white when it comes from the tree, and changes first to a green, and afterwards to a gold colour.

2. Copaiva.—This balsam is obtained from the Copaifera Officinalis; a tree which grows in South America, and some of the West Indian islands. It exudes from incisions made in the trunk of the tree. The juice thus obtained is transparent, of a yellowish colour, an agreeable smell, a pungent taste, at first of the consistence of oil, but it gradually becomes as thick as honey. Its specific gravity is 0.950. When mixed with water and distilled, there comes over with the water a very large portion of volatile oil. The oil ceases to come over before all the water has passed into the receiver. The residuum of course consists of two substances; namely, the watery portion, and a greyish yellow substance, lying at the bottom of the vessel, which, on exposure to the air, dries, and becomes brittle and transparent. When heated, it melts, and possesses the characters of a resin. Nitric acid acts upon this balsam with considerable energy. When one part of the balsam is mixed with four parts of nitric acid and two parts of water, and heated, a yellowish solution is formed, similar to the original balsam, but darker. When distilled, there comes over with the liquid that passes into the receiver an apple-green oil, which lines the helm of the retort. The nature of the residue was not examined. When treated with sulphuric acid, it yields a portion of artificial tannin. Whether this balsam yields benzoic acid, has not been ascertained: its properties are rather against the probability of its doing so. Indeed it bears a striking resemblance to turpentine in many respects; and ought, along with it, to constitute a class of bodies intermediate between volatile oils and resins, to which the name of turpentine might be given.

3. Balsam of Tolu.—This substance is obtained from the Toluifera balsamum, a tree which grows in South America. The balsam flows from incisions made in the bark. It comes to Europe in small gourd shells. It is of a reddish brown colour and considerable consistence, and when exposed to the air it becomes solid and brittle. Its smell is fragrant, and continues so even after the balsam has become thick by age. When distilled with water, it yields very little volatile oil, but impregnates the water strongly with its taste and smell. A quantity of benzoic acid sublimes, if the distillation be continued. Mr. Hatchett found it soluble in the alkalies, like the rest of the balsams. When he dissolved it in the smallest possible quantity of lixivium of potash, it completely loses its own odour, and assumes a most fragrant smell, somewhat resembling that of the clove pink. "This smell," Mr. Hatchett observes, "is not fugitive, for it is still retained by a solution which was prepared in June, and has remained in an open glass during four months." When digested in sulphuric acid, a considerable quantity of pure benzoic acid sublimes. When the solution of it in this acid is evaporated to dryness, and the residuum treated with alcohol, a portion of artificial tannin is obtained; the residual charcoal amounts to 0.54 of the original balsam.

4. Balsam of Peru is obtained from the Myroxylon Peruiferum. The tree is full

of resin, and the balsam is obtained by boiling the twigs in water. It has the consistency of honey, a brown colour, an agreeable smell, and a hot acrid taste. When boiled with water for some time, the liquid separated by the filter reddens vegetable blues, and deposits crystals of benzoic acid on cooling. The water contains no other substance. When distilled with water, it yields a very small quantity of reddish limpid oil. A saturated solution of carbonate of soda forms with this balsam a thick mass. When diluted with water, and heated, a portion is dissolved. The solution, when saturated with sulphuric acid, deposits crystals of benzoic acid. One part of the balsam, treated with one part of potash dissolved in four parts of water, formed an opaque solution, which gradually separated into two portions: the uppermost, a clear oil, with some grey flakes at its lower surface; the undermost, a dark brownish red opaque solution. This last solution, when saturated with sulphuric acid, let fall a resinous-like substance, dissolved by boiling, while benzoic acid crystallized. Nitric acid acts upon the balsam with energy, and gives it an orange yellow colour, when assisted by heat. When distilled with a sufficient quantity of this acid diluted, the liquid in the receiver smells of bitter almonds. When this balsam is treated with sulphuric acid, artificial tannin is also formed, and the residual charcoal amounts to no less than 0.64 of the original weight of the balsam.

5. Styrax.—This is a semifluid juice, said to be obtained from the Styrace officinale, a tree which grows in Virginia, Mexico, and some other parts of America. It is prepared in the island Cobrass, in the Red Sea, from the bark of a tree called rosa mallos by the natives, and considered by botanists as the same with the American species. The bark of this tree is boiled in salt water to the consistence of bird-lime, and then put into casks. Bouillon la Grange has published an account of its properties. Its colour is greenish, its taste aromatic, and its smell agreeable. It is easily volatilized by heat. When treated with water, benzoic acid is dissolved. It is totally soluble in alcohol, except the impurities. When exposed to the air, it becomes harder, and absorbs oxygen. When distilled, it yields an acidulous water, having the odour of benzoic acid, a limpid colourless hot oil, a solid coloured oil, benzoic acid, and a mixture of carbonic acid and carburetted hydrogen. The charcoal is light, and contains some oil.

Solid balsams. The solid balsams at present known are only three in number; namely,

1. Benzoin. 3. Dragon's blood.
2. Storax.

1. Benzoin.—This substance is the produce of the styrax benzoe, a tree which grows in Sumatra, &c. and which has been described by Dr. Dryander. Benzoin is obtained from this tree by incision; a tree yielding three or four pounds. It is a solid, brittle substance, sometimes in the form of yellowish white tears, joined together by a brown substance, and sometimes in the form of a brown substance, not unlike common rosin. It has a very agreeable smell, which is increased by heating the benzoin. It has little taste. Its specific gravity is 1.092. Alcohol dissolves it when assisted by a gentle heat, and forms a deep yellow solution, inclining to reddish brown. When this solution is diluted with water, the benzoin precipitates in the form of a white powder. It is precipitated also by muriatic and acetic acids, but not by the alkalies. A few drops of sulphuric acid likewise precipitate the benzoin; but an additional quantity re-dissolves it, and forms a liquid, of the colour of port wine. Nitric acid acts with violence on benzoin, and converts it into an orange-coloured mass. When assisted by heat, the acid dissolves the benzoin; and as the solution cools, crystals of benzoic acid gradually separate. Mr. Hatchett ascertained, that by this process a quantity of artificial tannin is formed. Sulphuric acid dissolves benzoin, while benzoic acid sublimes; the solution is at first a deep red. By continuing the digestion, a portion of artificial tannin is formed, and the charcoal evolved amounts to 0.48 of the benzoin dissolved. Acetic acid dissolves benzoin without the assistance of heat. When heat is applied, the solution, as it cools, becomes turbid; owing to the separation of benzoic acid. Benzoin is dissolved by a boiling lixivium of the fixed alkalies; a dark brown solution is formed, which becomes turbid after some days exposure to the air. Ammonia likewise dissolves benzoin sparingly.

2. Storax.—This is the most fragrant of all the balsams, and is obtained from the styrax officinalis, a tree which grows in the Levant, and it is said also in Italy. Sometimes it is in the state of red tears: and this is said to be the state in which

it is obtained from the tree. But common storax is in large cakes, brittle, but soft to the touch, and of a reddish brown colour. It dissolves in alcohol.

3. Dragon's blood.—This is a brittle substance, of a dark red colour, which comes from the East Indies. There are two sorts of it; one in small oval drops, or tears, of a fine deep red, which becomes crimson when the tears are reduced to powder; the other is in larger masses, some of which are pale red, and others dark. It is probably obtained from different kinds of trees; the calamus draco is said to furnish most of what comes from India. The dracæna draco and the pterocarpus draco are also said to furnish it. Dragon's blood is brittle and tasteless, and has no sensible smell. Water does not act upon it, but alcohol dissolves the greatest part, leaving a whitish red substance, partially acted upon by water. The solution has a fine deep red colour, which stains marble, and the stain penetrates the deeper the hotter the marble is. It dissolves also in oils, and gives them a deep red colour also. When heated, it melts, catches flame, and emits an acid fume similar to that of benzoic acid. When digested with lime, a portion of it becomes soluble in water, and it acquires a balsamic odour.

Balsam. See Pharmacy.

BALSAMINA, in botany. See Impatiens.

BALSAMITA, in botany, a genus of the Syngenesia Æqualis class and order. Receptacle naked; calyx imbricate. Four species, found in Crete, Nice, Barbary, and Italy.

BALTIMORA, in botany, so named by Linnæus, in honour of Lord Baltimore, a genus of the Syngenesia Polygamia Necessaria class and order. Natural order, compositæ oppositifoliæ: corymbiforeæ, Jussieu. Essential character: calyx cylindric, many-leaved; ray of the corolla five-flowered; receptacle chaffy. One species, B. recta, which is a native of Maryland; an annual plant, about two feet high; it flowers in June and July.

BAMBOE, or Bambou, a plant in the Indies which multiplies very much by its root, from which springs a branchy tuft, after the manner of the European reeds. It is of the largest kind of cane, and decreases gradually to the top, where it bears a blossom like our reeds. The bamboe is a species of arundo. See Arundo.

The bamboo-cane grows naturally almost every where within the tropical regions; it is common in many parts of Asia, as China, Cochin-China, Tonquin, Cambodia, Japan, Ceylon, the Peninsula of India, and the islands. This useful plant has been long introduced into the West Indies. There are some fine specimens of bamboo in the Botanical Garden at Liverpool. Scarcely any plant serves for more useful purposes than the bamboo, where it grows naturally. In the East Indies, great use is made of it in building, and the houses of the meaner people are almost entirely composed of it. Bridges are also made of it, masts for their sailing vessels, boxes, cups, baskets, mats, and a great variety of other utensils and furniture. Paper is also made from it by bruising and steeping it in water, and thus forming it into a pulp. It is the common fence for gardens and fields, and is frequently used as pipes for conveying water. The leaves are generally put round the chests of tea which are sent to Europe from China, as package fastened together so as to form a kind of mat. The tops of the tender shoots are frequently pickled in the West Indies. In the cavities of the bamboo is found, at certain seasons, a concrete white substance, which the Arabian physicians hold in high estimation.

BAN, in law, a public notice, applied particularly to the publication of intended marriages, which must be done on three several Sundays previously to marriage, that if any shew just cause against such marriage, they may have an opportunity to set forth their objections.

BANARA, in botany, a genus of the Dodecandria Monogynia class and order. Natural order, columniferæ; tiliaceæ, Jussieu. Essential character: calyx six-parted, permanent; corolla six-petalled; germ seated on a glandule; stigma headed; berry globose, one-celled, and many-seeded. One species, B. guiannois, a tree of ten feet or more in height, and about seven inches in diameter, with a greyish bark, and a whitish light wood: a native of the island of Cayenne; flowering in May, and bearing fruit in July.

BANDAGE, in surgery, a fillet, a roller, or swathe, used in dressing and binding up wounds, restraining dangerous hæmorrhages, and in joining fractured or dislocated bones. See Surgery.

BANDEROLL, a little flag in form of a guidon, extended more in length than breadth, used to be hung out on the masts of vessels, &c.

BANE, in law, destruction, as he who is the cause of another man's death is said to be *le bane*, that is, a malefactor. Bracton.

BANERET. See BANNERET.

BANIAN *days*, a sea term among sailors, to signify those days in which they have no meat. It was probably derived from the practice of the Banians, which see.

BANIANS, a religious sect in the empire of the Mogul, who believe a metempsychosis, and will therefore eat no living creature, nor even kill noxious animals; but endeavour to release them when in the hands of others.

The Banians are said to be so fearful of having communication with other nations, that they break their cups, if one of a different religion has drank out of them, or even touched them. It is said, that if they happen to touch one another, they purify and wash themselves before they eat, or enter their own houses. They carry, hanging to their necks, a stone called tamberane, as big as an egg, and perforated in the middle, through which run three strings; this stone, they say, represents their great god, and upon that account they have great respect shewn them by all the Indians.

BANISHMENT is the quitting of the realm: there are two kinds of it, one voluntary, called abjuration, and the other upon compulsion, for some offence. By the habeas corpus act no subject of this realm, who is an inhabitant of England, Wales, or Berwick, shall be sent prisoner into Scotland, Ireland, Jersey, Guernsey, or place beyond seas, where they cannot have the protection of the common law, for by it every Englishman may claim a right to abide in his own country so long as he pleases, and not be banished or driven from it but by sentence of the law.

BANISTERIA, in botany, named after the Rev. John Banister, a curious botanist, who lost his life in the search of plants in Virginia; a genus of the Decandria Trigynia class and order. Natural order, trihilatæ, malphigiæ. Essential character: calyx five-parted, with melliferous pores at the base on the outside; petal roundish with claws; stigmas leaf-shaped; seeds three winged, with membranes. There are 24 species, all of which are inhabitants of very hot climates, chiefly in America, from Brazil to Louisiana, particularly the islands. They are shrubs, mostly with twining stems, adorning the woods with the beauty of their flowers, and the variety of their opposite leaves. They cannot be preserved in England unless they are kept in a bark stove. They are propagated by seeds, which must be procured from the countries where they grow naturally. The seeds must be fully ripe, and put into sand or earth, in which they should be sent to England, otherwise they will not grow: when they arrive they should be immediately sown in pots; and if it happen in autumn or winter, the pots should be plunged into a hot-bed of tanner's bark, and secured from frost and wet till spring, when they must be removed to a fresh hot-bed, which will bring up the plants; but if they should not appear the first year, the pots should be preserved till the next spring, as the plants may come up then. When the plants appear, they must be treated like other tender plants from the same countries.

BANKS, *in commerce*, are of three kinds, *viz. banks of deposit, banks of discount*, and *banks of circulation. Banks of deposit* have been instituted, 1st, with a view of affording security against the loss of money by pillage or fire; 2dly, for the purpose of affording facilities to commercial transactions, by substituting a transfer on the books of the bank, in the place of the actual payment in coin of the sums to be expended; and 3dly, for the purpose of establishing a circulating medium equivalent to coin of a standard weight, as described below in relation to the bank of Amsterdam. *Banks of discount*, are institutions possessed of capitals, which, with the money placed on deposit, are employed in the discounting of promissory notes, bills of exchange, and other securities. *Banks of circulation*, in addition to the loan of their capitals, issue promissory notes, payable on demand, for such an additional amount, as the circulation of their neighbourhoods will easily bear, without rendering themselves liable to more demands than the specie in their coffers can at any time discharge. Most banks, particularly in the United States, are banks of circulation, and are there almost exclusively owned by incorporated bodies, chartered for the purpose by their respective states. In England, the great mass of banks are the establishments of one or a few individuals. The facilities which banks afford to commerce, added to the benefits which the countries in which they are situated derive from the substitution of a paper medium for one of coin, are such as have induced the principal nations of Europe and elsewhere to patronise and authorise their establishments. The bank of Venice was established as early as about the year 1157, the bank of Genoa in 1345, the bank of Amsterdam in 1609, the bank of Hamburg in 1619, the bank of Rotterdam in 1635, the bank of England in 1694, the bank of Scotland in 1695, the bank of France in 1716, the bank of North America in 1781, and the bank of the United States in 1791.

The *bank of Amsterdam* was solely a bank of deposit. The chief design of its institution was, to establish a currency, which, having a relation to the intrinsic value of coins, without regard to the clipped, worn, and consequently depreciated currency then in common use, should maintain a permanent equivalency with the standard money of the country. Its capital consisted of the "deposits made by merchants and others of coins, as well foreign as domestic, light or standard, for the *intrinsic value* of which, without regard to their denominative value, they received a credit on the books of the bank, transferable at pleasure; and as, by law, all bills of exchange for 600 guilders and upwards were payable in *bank money*, a sound currency, favourable to the exchanges of the city, was regularly maintained. For a particular account of this bank, see Smith's Wealth of Nations, Book iv. chap. iii.

Bank of the United States. The first institution which bore this title was incorporated by act of congress on the 25th day of February 1791, with a charter to continue until the 3d of March 1811. Its capital was ten millions of dollars, of which two millions was specie, and six millions funded debt bearing 6 per cent. interest, subscribed by individuals, bodies corporate, &c. The remaining two millions was subscribed by the government, and paid for by a loan made to it by the bank. It had branches at Boston, New-York, Baltimore, Washington, Norfolk, Charleston, Savannah, and New-Orleans, at each of which places the business of the branch, denominated the office of discount and deposit, was conducted by a president and twelve directors, who were annually chosen by the twenty-five directors of the mother bank located at Philadelphia. A considerable portion of the stock of this bank was eventually held by Europeans, a circumstance highly beneficial to the country, as the investments thus made constituted a permanent loan of capital to the nation. The plan of this bank was projected by Alexander Hamilton, the first secretary of the treasury after the organization of the government. Towards the expiration of its charter, strenuous exertions were made by the stockholders and other friends of the institution, to obtain a renewal of it, but it was refused by congress, and the bank was compelled to wind up its concerns. This it progressed in by a gradual diminution of its loans, and a simultaneous division of its capital; and the result, as far as it has been ascertained, has proved satisfactory to the proprietors and to the public. At this period, (September 1816) after the whole of the original capital of ten millions has been paid, a balance due the bank of near 400,000 dollars remains uncollected, and upwards of 200,000 dollars of notes remain yet in circulation. Should all their debts be collected, a surplus fund of 600,000 dollars will be in the hands of the trustees. The dividend of this bank, from its institution to its close, averaged about 8⅓ per cent. per annum.

The second *Bank of the United States* was incorporated by act of congress on the 10th of April, 1816, with a charter to extend until the 3d day of March 1836, of which the following are the principal outlines. Capital 35 millions of dollars, divided into shares of 100 dollars each, to consist of 7 millions of specie, 21 millions of the 6 per cent. funded debt of the United States (or an equivalent in 3 and 7 per cent. stock) to be subscribed by individuals, corporations, or states, and 7 millions of stock bearing five per cent. interest, to be subscribed by the government. The whole, except the sum subscribed by the government, to be paid in instalments as follows, *viz.* 30 per cent. at the time of subscribing, of which five per cent. to be in coin; 35 per cent. at the expiration of six months, of which 10 per cent. to be in coin, and 35 per cent. at the expiration of twelve months from the time of subscribing, of which 10 per cent. to be coin. The bank to be managed by twenty-five directors, 5 of whom are to be appointed by the president and senate, and twenty to be chosen by the stockholders annually, on the first Monday in January. The president of the bank to be appointed annually by a majority of the board of directors. No stockholder to be entitled to more than 30 votes. The bank never to be in debt over and above its deposit money, more than 35 millions of dollars, and to be allowed the privilege of establishing branches upon certain conditions. No note to be issued for a less amount than five dollars. The notes of the bank to be received in all payments to the United States, unless otherwise directed by act of congress. The bank, in case of refusal to pay its notes or deposit money agreeably to contract, to be liable to an interest of 12 per cent. per annum during the suspension. A bonus of 1,500,000 dollars to be paid to the government for the charter, which is declared to be exclusive.

In pursuance of the provisions of the act incorporating the bank, the books were opened by the commissioners appointed for the purpose, at the principal city or town of each of the states, on the first of July, 1816. The result was, a deficiency of subscriptions to the amount of 3,044,800 dollars, which, upon the re-opening of the books at Philadelphia, on the 26th day of August following, was readily supplied. The first election for directors is to take place at Philadelphia, the seat of the bank, on the 28th day of October, and it is expected that the bank will go into operation prior to the first of January, 1817.

All the banks in the United States, except those of the New England States, suspended specie payments in the months of August or September, 1814, and have not yet (Sept. 1816,) resumed them, although it is probable that such an arrangement will be effected on or before the 1st of July, 1817.

Bank *of England*, was projected by Mr. W. Paterson, a merchant, who, in conjunction with others, arranged the establishment, for which, with some difficulty, they obtained the sanction of parliament. The charter was executed July 27, 1694, and was granted for the term of twelve years, the corporation being then determinable on a year's notice. The original capital subscribed was 1,200,000*l.* which they lent to government at 8 per cent. interest, with an allowance of 4000*l.* per ann. for their expenses of management.

In less than two years from its establishment the company was involved in much difficulty from the bad state of the silver coin, and the great discount to which all public securities had fallen; the impossibility of getting a sufficient supply of cash during the re-coinage reduced them to the necessity of paying their notes by small instalments, and of issuing bonds bearing interest, in exchange for their cash notes. These difficulties, however, were overcome by prudent management, and the responsibility and reputation of the bank became fully established. The term of the charter was, in 1706, extended to five years beyond the original period, in consideration of the company having undertaken to circulate for government exchequer bills to the amount of 1,500,000*l.* and it has since been further extended at different times, *viz.*

In 1709 to 1st of August 1732
1713 1742
1742 1764
1763 1786
1781 1812
1800 1833

On all these occasions the company have either paid a considerable sum, or advanced a greater amount by way of loan to government, as a consideration for the renewal of their exclusive privileges, and for the advantages they derive from acting as the agents for government in all money transactions of any importance. Their chief privilege consists in the prohibition of all other companies or partnerships of more than six persons, from issuing bills or notes payable on demand, or for any time less than six months.

The total permanent debt due from government to the bank is 11,686,800*l.* bearing 3 per cent. interest; but the capital stock of the company is 11,642,400*l.* on which they pay a dividend of 10 per cent. per ann. to the proprietors.

The notes of the bank of England are the representative of money in all the commercial transactions of London and its vicinity, and from the vast magnitude of the payments in which they are employed, the total amount in circulation, which till within a few years was never made public, was generally thought to be much greater than it has since appeared to have been. The total amount of bank notes in circulation on the 25th of February, 1787, was 8,688,570*l.* which, on the 25th of February, 1793, had increased to 11,451,180*l.* Soon after this period the temporary annual advances which the bank had long been accustomed to make to government were increased; while an advance in the price of gold, in consequence of the great exportation of coin and bullion to Germany and Ireland, greatly reduced the quantity in the hands of the bank, and consequently rendered it impracticable to maintain the same amount of notes in circulation. An alarm of invasion, in the beginning of the year 1797, greatly increased the demands on the bank for cash, and it was deemed necessary for the government to interfere and authorise a suspension of payment in cash for bank notes, for a limited period: the continuance of the suspension was at first renewed annually, and afterwards till the return of peace. In order to supply a substitute for coin for making small payments, the bank issued notes of

2*l.* and 1*l.* each, and as the demand for notes of this description has increased, the total amount of bank notes in circulation has become considerably greater than previous to the suspension of issuing cash, *viz.*

On the 1st of Feb. 1805, *l.*18,397,880
. . . . 1806, 17,293,570
. . . . 1808, 16,621,390

From the reports of the secret committee appointed in 1797 to investigate the affairs of the bank, it appeared, that on the 25th of February, in that year, there was a balance of 3,826,903*l.* and on the 11th of November a balance of 3,837,550*l.* in favour of the company; their profits since must have been greater than while they were obliged to maintain a large stock of cash to answer their notes, which has enabled them to make several occasional dividends to their proprietors, and at Lady-day, 1807, to raise their usual dividend from 7 per cent. which it had been for the last 19 years, to 10 per cent.

The profits of the company arise from the interest received from government on the permanent debt, and on their annual advances on exchequer bills and treasury bills of exchange; from their allowance for receiving the contributions to loans, and for paying the dividends on the public funds; from dealing in bullion, and discounting mercantile bills of exchange, and other sources of less importance.

The concern is under the management of a governor, deputy governor, and twenty-four directors, who are elected annually. 500*l.* bank stock entitles the proprietor to a vote at the general courts, and no proprietor is entitled to more than one vote for any sum whatever.

Bank *of Scotland*, was established under the superintendance of Mr. W. Paterson, from whom the plan of the bank of England originated. It was erected by an act of the parliament of Scotland in 1695, and although its capital stock was only 1,200,000*l.* Scots, or 100,000*l.* sterling, it was soon found very beneficial to the commerce of North Britain. In 1774 they were authorised to increase their capital 1,200,000*l.* Scots, or 100,000*l.* sterling; and in 1784 another addition was made of the same amount. By an act passed in 1792, they were empowered to double the existing capital, which thus became equal to 600,000*l.* sterling, and in 1774 a further addition was made, equal to 400,000*l.* sterling; the total capital thus became 12,000,000*l.* Scots, or 1,000,000*l.* sterling. The company is under the management of a governor, a deputy governor, twelve ordinary directors, and twelve extraordinary directors.

Bank, *Royal, of Scotland,* was established by charter in 1727, with a capital of 151,000*l.* sterling. The public revenues of Scotland are paid into this bank, and it is under the management of a governor, deputy governor, and sixteen directors.

Bank *of Ireland,* was established in the year 1781. The original capital was only 600,000*l.* and the company's privileges were determinable on twelve month's notice after the 1st of January, 1794. Previous to this period the capital was increased to 1,000,000*l.* and the term extended to the 1st of January, 1816; and by a subsequent act they were empowered to augment their capital to 1,500,000*l.* In the original act by which this bank was established, it was directed that they should not borrow or give security by bill, bond, note, covenant, or agreement, under their common seal or otherwise, for any sum exceeding their capital; and a clause to a similar purport, though not in the same precise words, was included in the subsequent acts. Since the suspension of payment in cash, however, the total amount of the notes of the bank of Ireland in circulation has been greatly increased, so that on the 1st of January, 1797, they amounted only to 621,917*l.* 6*s.* 4*d.* including bank post bills, whereas on the 1st of February, 1806, the amount of their notes of 5*l.* value and upwards was 1,676,118*l.* 11*s.* 2½*d.* and of notes under 5*l.* value 811,454*l.* 10*s.* 9*d.* making together 2,487,573*l.* 1*s.* 11½*d.*

The bank rceives interest at 5 per cent. from the government, on their permanent and temporary loans; and an allowance for management of such part of the public debt as has been made transferable at the bank of Ireland.

Bank, in natural history, denotes an elevation of the ground, or bottom of the sea, so as sometimes to surmount the surface of the water, or, at least, to leave the water so shallow, as usually not to allow a vessel to remain afloat over it.

In this sense, bank amounts to much the same with flat, shoal, &c. There are banks of sand, and others of stone, called also shelves, or rocks. In the North sea, they also speak of banks of ice, which are large pieces of that matter floating.

A long narrow bank is sometimes called a rib.

The bank, absolutely so called, or the

main bank, or great bank, denotes that of Newfoundland, the scene of the cod fishery.

It is called the great bank, not only by reason of its vast extent, being, according to the English computation, 200 miles long, and, according to the French, 100 leagues, or 300 miles; but also on account of several lesser banks near it, where cod are also caught.

Banks, on the sea coast, are usually marked by beacons, or buoys, and in charts they are disinguished by little dots, as ridges of rocks are by crosses. An exact knowledge of the banks, their extent, and the depth of water on them, makes a most essential part of the science of a pilot, and master of a ship; if the vessel be large, and draw much water, great attention will be necessary to keep clear of the banks; on the contrary, if it be small, the same banks afford a sure asylum, where it may brave the largest and stoutest vessels, which dare not follow it here. By means of this barrier many small craft have escaped their enemies.

Bank, in vessels which go with oars, is used for the bench where the rowers are seated; popularly called by our seamen the thaught.

In this sense we read of banks of gallies, of galeasses, of galliottes, of brigantines, and the like.

The Venetian gondolas have no banks; for the watermen row standing.

The common gallies have 25 banks, that is, 25 on each side, in all 50 banks, with one oar to each bank, and four or five men to each oar.

The galeasses have 32 banks on a side, and six or seven rowers to a bank.

BANKAFALET, a game at cards, which being cut into as many heaps as there are players, every man lays as much money on his own card as he pleases; and the dealer wins or loses as many as his card is superior or inferior to those of the other gamesters.

The best card is the ace of diamonds; the next to it, the ace of hearts: then the ace of clubs; and, lastly, the ace of spades; and so of the rest of these suits in order, according to their degree.

The cheat lies in securing an ace, or any other sure winning card; which are somehow marked, that the sharper may know them.

BANKER, a person who traffics and negociates in money, who receives and remits money from place to place, by commission from correspondents, or by means of bills or letters of exchange.

In France it is not requisite that a man be a merchant, in order to carry on banking; for that trade is permitted to all sorts of persons, even to foreigners, so far as relates to foreign banking, or dealing by exchange.

In Italy, the trade of a banker does not derogate from nobility, which is the reason why most of the younger sons of the quality apply themselves to that employment, in order to support their families. The monied goldsmiths in the reign of king Charles the Second first acquired this name.

The Romans had two sorts of bankers, whose office was much more extensive than that of the bankers among us; theirs being that of public affairs, in whom were united the functions of a broker, agent, banker, and notary, managing the exchange, taking in money, assisting in buying and selling, and drawing the writings necessary on all these occasions.

BANKRUPT, a trader, whom misfortune or extravagance has induced to commit an act of bankruptcy. The benefit of the bankrupt laws is allowed to none but actual traders, or such as buy and sell, and gain a livelihood by so doing.

Requisites to constitute a trading, the merchandising, or buying and selling, must be of that kind, whereby the party gains a credit upon the profits of an uncertain capital stock. Manufacturers, or persons purchasing goods or raw materials to sell again, under other forms, or meliorated by labour; as bakers, brewers, butchers, shoemakers, smiths, tanners, tailors, &c. are also within the statutes.

The following description of persons are not within the statutes of bankruptcy; *viz.* proprietors or persons having an interest in land, if buying and selling to whatever extent, for the purposes of disposing merely of the produce and profits of such land; graziers and drovers; owners of coal mines, working and selling the coals; owners or farmers of alum rocks; farmers who make cheese for sale; or those who sell cider made from apples of their own orchard.

In all such cases, and others of a similar nature, where the several materials are purchased, and even some kind of manufacture exercised; yet as this is the necessary and customary mode of receiving the benefit arising from the land, such persons are not held to be traders within the statutes; nor are persons buying and selling bank stock or government securities. Buying or selling, only, will neither singly constitute trading; neither will a single act of buying and selling, or drawing, or redrawing bills of exchange, merely for the purpose of raising money for private occasions, and not with a view to gain a profit upon the exchange. Being a part-owner in a ship, barge, or waggon, does not constitute a trader; nor holding a share or interest in a joint stock with others who trade, unless he share in the profit and loss upon the disposition of the capital. The merchandise must also be general, and not in a qualified manner only, as victuallers or innkeepers; schoolmasters; commissioners of the navy, who victual the fleet by private contract; the king's butler, steward, or other officers; officers of excise or custom; sutlers of the armies; butlers; stewards of inns of court; clergymen; &c. as acting in such capacities merely, are not liable to be made bankrupts; the buying and selling in such cases not being general, but in the exercise of particular employments. Neither, upon the same principle, are receivers of the king's taxes, or persons discounting exchequer bills. If the parties above enumerated, however, bring themselves within the bankrupt laws in any other respect, they will be liable to their operation, although they should evidently not profit by trading, or such trading should be illegal; although the trading should not be wholly carried on in England, buying only in England, and selling beyond sea. Any person, native, denizen, or alien, residing in any part of the British dominions, or in foreign countries, though never a resident trader in England, yet, if he be a trader, and on coming to England commit an act of bankruptcy, he will be subject to the bankrupt laws.

No one can be a bankrupt, on account of any debt which he is not compellable by law to discharge, as infants or married women. And if a single woman be a trader, and committing any act of bankruptcy, afterwards marry, a commission issued against her after such marriage cannot be supported. But, according to the custom of London, where a married woman is sole trader, she is held liable to a commission of bankruptcy, like a feme sole.

Acts of bankruptcy. Departing the realm. This must be done with intent to defraud or delay creditors; when it appears that there was no such intention, it will not be a departure within the meaning of the statutes.

Departing from the dwelling-house. Such departure must also be with intent to defraud and delay creditors; for the departure with an intent to delay has been held insufficient, without an actual delay of some creditors.

Beginning to keep the house, the being denied to a creditor, who calls for money; but an order to be denied is not enough, without an actual denial, and that also to a creditor who has a debt demandable at the time.

Voluntary arrest, not only for a fictitious debt, but even for a just one, if done with the intent to delay creditors, is an act of bankruptcy.

Suffering outlawry, with an intent to defraud the creditors; but this will not make a man a bankrupt, if reversed before issuing a commission, or for default of proclamations after it, unless such outlawry were originally fraudulent.

Escaping from prison. Being arrested for a just debt of 100*l.* or upwards, and escaping against the consent of the sheriff.

Fraudulent procurement of goods to be attached or sequestered.

A fraudulent execution, though void against creditors, is not within the meaning of the words attachment, or sequestration, used in the statute; because they relate only to proceedings used in London, Bristol, and other places.

Making any fraudulent conveyance. Any conveyance of property, whether total or partial, made with a view to defeat the claims of creditors, is a fraud, and, if it be by deed, is held to be an act of bankruptcy.

A conveyance by a trader of all his effects and stock in trade by deed, to the exclusion of any one or more of his creditors, has been ever held to be an act of bankruptcy.

A mortgage (amongst other things) of all the stock in trade of a tradesman, was held to be an act of bankruptcy, as being an assignment of all the stock in trade, without which he could carry on no business.

A conveyance by a trader, of part of his effects to a particular creditor, carries no evidence whatever of fraud, unless made in contemplation of bankruptcy.

Being arrested for debt, lying in prison two months, or more, upon that or any other arrest, or detention in prison for debt, will make the party a bankrupt, from the time of the first arrest; but where the bail is fairly put in, and the party at a future day surrenders in discharge of his bail, the two months are computed from the time of the surrender.

BANKRUPTCY, *proceedings of*, under a commission. The Lord Chancellor is empowered to issue a commission of bankrupt, and is bound to grant it as a matter of right. By 5 Geo. II. c. 30, no commission can issue, unless upon the petition of a single creditor, to whom the bankrupt owes a debt, which shall amount to 100*l.* the debt of two or more, being partners, shall amount to 150*l.* and of three or more to 200*l.*

If the debt against the bankrupt amount to the sum required, it is not material, though the creditor should have acquired it for less.

If a creditor to the full amount, before an act of bankruptcy committed, receive, after notice of the bankruptcy, a part of his debt, such payment being illegal, cannot be retained, and the original debt remains in force, and will support a commission.

The debt must be a legal, and not an equitable, one, and if the legal demand be not in its nature assignable, the assignee cannot be the petitioning creditor, as the assignee of a bond.

If the creditor, for a debt at law, have the body of his debtor in execution, he cannot at the same time sue out a commission upon it; that being, in point of law, a satisfaction for the debt.

Of opening the commission. When the commissioners have received proof of the petitioning creditor's debt, the trading, and act of bankruptcy, they declare and adjudge the party a bankrupt. They are authorised to issue a warrant, under their hands and seals, for the seizure of all the bankrupt's effects, books, or writings, and for that purpose to enter the house, or any other place belonging to the bankrupt.

Such debts only can be proved under a commission, as were either debts certainly payable, and which existed at the time of the bankruptcy, or which, although originally contingent, yet, from the contingency happening before the bankruptcy, were become absolute. In every case the amount of the debt must be precisely ascertained.

Time and method of proving. Creditors were formerly precluded from proving after four months, but the court now, except in cases of gross negligence, allows them to come in at any time, whilst any thing remains to be disposed of. The usual proof required, is the oath of the creditor himself, either in person, or by affidavit, if he live remote from the place of meeting, or reside in foreign parts. 5 Geo. II.

Corporations, or companies, are generally admitted to prove by a treasurer, clerk, or other officer duly authorized.

Of the assignees. Immediately after declaration of the bankruptcy, the commissioners are to appoint a time and place for the creditors to meet and choose assignees; and are directed to assign the bankrupt's estates and effects to such persons as shall be chosen by the major part in value.

The powers and duties of assignees are principally those of collecting the bankrupt's property, reducing the whole into ready money, and making distribution as early as possible. One assignee is not answerable for the neglect of another. Assignees, if they act improperly, are not only liable at law to the creditors for a breach of trust, but may be removed on account of misbehaviour, &c. by petitioning the Lord Chancellor. Upon the removal of an assignee, he is directed to join with the remaining one in assignment to the latter and new assignee.

Provisions for wife, children, &c. By the statute of Elizabeth, the commissioners may assign any lands, &c. that the bankrupt shall have purchased jointly with his wife, and the assignment shall be effectual, against the bankrupt, his wife, or children; but this shall not extend to conveyances made before the bankruptcy, bona fide, and not to the use of the bankrupt himself only, or his heirs, and where the party to the conveyance are not privy to the fraudulent purposes to deceive the creditors.

Examination of the bankrupt. By the 5th Geo. II. the commissioners are empowered to examine the bankrupt, and all others, as well by parole, as by interrogations in writing. The said statute requires the bankrupt to discover all his estate and effects, and how, and to whom, and in what manner, on what consideration, and at what time, he has disposed of them; and all books or papers, and writings relative thereto, of which he was possessed or interested, or whereby he or his family may expect any profit, advantage, &c. and on such examination he shall deliver up to the commissioners all his effects, (except the necessary wearing apparel of himself, his wife, and children,) and all books, papers, and writings, relating thereto.

With respect to his privileges from arrest. By the above act, the bankrupt shall be free from all arrest in coming to surrender, and from his actual surrender to the commissioners for and during the 42 days, or the further time allowed to finish his examination, provided he was not in custody at the time of his surrender.

Books and papers. By 5 Geo. II. c. 30, the bankrupt is entitled, before the expiration of the 42 days, or enlarged time, to inspect his books and papers, in the presence of the assignees, or some person appointed by them, and make such extracts as he shall deem necessary.

Power of commissioners in case of contumacy. The statutes empower the commissioners to enforce their authority by commitment of the party, in the following cases: persons refusing to attend on the commissioners' summons; refusing to be examined, or to be sworn, or to sign and subscribe their examination; or not fully answering, to the satisfaction of the commissioners.

Of the certificate. By the 5 Geo. II. a bankrupt surrendering, making a full discovery, and in all things conforming to the directions of the act, may, with the consent of his creditors, obtain a certificate.

If the commissioners certify his conformity, and the same be allowed by the Lord Chancellor, his person, and whatever property he may afterwards acquire, will be discharged and exonerated from all debts owing by him at the time he became a bankrupt. But no bankrupt is entitled to the benefit of the act, unless four parts in five, both in number and value, of his creditors, who shall be creditors for not less than 20*l.* respectively, and who shall have duly proved their debts under the commission, or some other person duly authorized by them, shall sign the certificate.

Of the dividends. The assignees are allowed four months, from the date of the commission, to make a dividend; and should apply to the commissioners to appoint a meeting for that purpose, or they may be summoned by them, to shew cause why they have have not done so.

Allowance to the bankrupt. Every bankrupt surrendering, and in all things conforming to the directions of the act, shall be allowed five per cent. out of the net produce of his estate, provided, after such allowance, it be sufficient to pay his creditors ten shillings in the pound, and that the said five per cent. shall not in the whole exceed 200*l.* Should his estate in like manner pay twelve shillings and six pence in the pound, he shall be allowed seven and an half per cent. so as not to exceed 250*l.* and if his estate pay fifteen shillings in the pound, he shall be allowed ten per cent. so as not to exceed 300*l.* But the bankrupt is not entitled to such allowance, till after a second dividend; nor can he be entitled to it till he has received his certificate.

Of the surplus. The commissioners are, on request of a bankrupt, to give a true and particular account of the application and disposal of his estate, and to pay the overplus, if any, to the bankrupt.

Of superseding commissions. Commissions may be superseded for the want of a sufficient debt of the petitioning creditor; or because he was an infant; or for want of sufficient evidence of the trading or act of bankruptcy; or in cases of fraud; or by agreement or consent of the creditors.

Joint commissions. Partners are liable to a joint commission, or individually, against each; but a joint and separate commission cannot, in point of law, be concurrent. A joint commission must include all partners; if there be three partners, and one of them an infant, there can neither be a commission against the three, nor against the other two.

Felony of bankrupts. If any person, who shall be duly declared a bankrupt, refuse, within 42 days after notice left at his place of abode, and in the London Gazette, to surrender himself to the commissioners, and to fully disclose and discover all his estate and effects, real and personal, and all transferrences thereof, and also all books, papers, and writings, relating thereto, and deliver up to the said commissioners all such estate and effects, books, papers, &c. as are in his power; (except his necessary wearing apparel, &c.) or in case he shall conceal or embezzle any part of his estate, real or personal, to the value of 20*l.* or any books of accounts, papers, or writings, relating thereto, with intent to defraud his creditors, being lawfully convicted thereof, by judgment or information, shall be adjudged guilty of felony, without benefit of clergy, and his goods divided amongst his creditors.

BANKSIA, in botany, so called in honour of Sir Joseph Banks, who first discovered it in his voyage with Captain Cook; a genus of the Tetrandria Monogynia class and order. Natural order of Aggregatæ. Proteæ, Jussieu. Essential character: calyx four-cleft, inferior; corolla four-parted; tube very short; border very long, linear, lanceolate; anthers sessile in the cavity of the parts of the corolla; capsule two-seeded, one (or two) celled,-two-valved. There are eight species. This genus is nearly allied to Protea and Embothrium in appearance and character, but is sufficiently distinguished from both in the fruit. It boasts some of the most specious plants that have been discovered in the South Seas, and even in the known world. Those with solitary flowers and one celled capsules, form a separate genus, which Dr Smith names Salisburia. Some of the species have flowered and seeded here; they have not yet been increased any other way but by seeds. These, and the plants in general from the South Seas, are hardy, considering their climate, and may be treated pretty much in the same manner with the Cape plants. They covet abundance of air, and flourish best near the front of the dry stove.

BANN, in military affairs, a proclamation made in the army, by beat of drum, sound of trumpet, &c. requiring the strict observance of discipline, either for the declaring a new officer, or punishing an offender.

Bann *of the empire*, an imperial proscription, being a judical punishment, wherewith such as are accessary to disturbing the public peace are judged unworthy of the immunities and protection of the empire, and are out-lawed or banished, &c.

BANNER denotes either a square flag or the principal standard belonging to a prince.

BANNERET, an ancient order of knights, or feudal lords, who, possessing several large fees, led their vassals to battle under their own flag, when summoned thereto by the king.

This order is certainly most honourable, as it never was conferred but upon some heroic action performed in the field. Anciently, there being but two kinds of knights, great and little, the first were called bannerets, the second batchelors; the first composed the upper, the second the middle nobility.

The form of the banneret's creation is this; on a day of battle the candidate presented his flag to the king or general, who, cutting off the train, or skirt thereof, and making it a square, returned it again; the proper banner of bannerets, who, from hence, are sometimes called knights of the square flag.

The late Sir William Erskine, on his return from the continent, in 1764, was made a knight banneret, in Hyde Park, by his present Majesty, in consequence of his distinguished conduct at the battle of Emsdorf. But he was not acknowledged as such in this country, because the ceremony did not take place where the engagement happened. Captain Trollope, of the royal navy, is the last created knight banneret.

BANNISTERIA, in botany, a distinct genus of plants, according to Linnæus; but accounted only a species of Clematis by other botanists.

It belongs to the Decandria Trigynia class; its flower consists of five very large, orbicular petals; and its fruit is composed of three unilocular capsules, running into long alæ.

BANTAM *work*, a kind of painted or carved work, resembling that of Japan, only more gaudy.

Bantam work is of less value among connoisseurs, though sometimes preferred, by the unskilful, to the true Japan work. Formerly it was in more use and esteem than at present, and the imitation of it much practised by our japanners.

There are two sorts of Bantam, as well as of Japan work; as, in the latter, some are flat, lying even with the black, and others high or embossed, so, in Bantam work, some is flat, and others in-cut, or carved into the wood, as we find in many large screens; with this difference, that the Japan artists work chiefly in gold and other metals, and the Bantam generally in colours, with a small sprinkling of gold here an there.

BAPTISM, in matters of religion, the ceremony of washing, by which a person is initiated into the christian church.

Baptism, in the sea-lauguage, a ceremony in long voyages on board merchant ships, practised both on persons and vessels, who pass the tropic or line for the first time. The baptising the vessels is simple, and consists only in washing them throughout with sea-water; that of the passengers is more mysterions. The oldest of the crew that has past the tropic, or line, comes with his face blacked, a grotesque cap on his head, and some sea-book in his hand, followed by the rest of the seamen dressed like himself, each having some kitchen utensil in his hand, with drums beating. He places himself on a seat on the deck, at the foot of the mainmast. At the tribunal of this mock magistrate, each passenger not yet initiated swears he will take care the same ceremony be observed, whenever he is in the like circumstances: then, by giving a little money by way of gratification, he is discharged with a little sprinkling of water, otherwise he is heartily drenched with streams of water, poured upon him; and the ship-boys are inclosed in a cage, and ducked at discretion. The seamen, on the baptizing a ship, pretend to a right of cutting off the break-head, unless redeemed by the captain.

BAPTISTS, or **ANTIPÆDOBAPTISTS**, in church history, a considerable sect, who are distinguished from other Christians by their opinions respecting baptism; and who maintain that the ordinance must be administered by the immersion of adults, and not by the sprinkling of infants. Such they say is the meaning of the word βαπτιζω: they call to their aid a variety of passages of scripture, none of which are however so decisive as to put the controversy to rest. And though it is certain that adults were baptised in the earliest periods of the christian system, there is no proof that infants were not admitted to the ordinance. It is not for us to enter into this controversy, which has been cut short by some other Christians, who maintain that baptism was intended only for the converts to the Christian faith, and was not to be repeated upon the children of believers. Hence many persons in the present day do not think it necessary to baptise their children, nor advise them to submit to it when they have attained to years of maturity. As the ordinance, when conducted with solemnity and liberality, is truly impressive, and as it does not occur to every one to witness such a scene during their lives, we shall extract an account of one performed in the neighbourgood of Cambridge, and which has been well described by the late excellent Mr. Robinson, whose name will live, when the distinction of sects and parties shall be obliterated from the Christian church, and when the only profession of faith will be that in the divine mission of the founder; happy day, when no man shall be excluded from the right hand of fellowship, because he cannot believe in dogmas of self-created censors, and who cannot join in the ceremonies, for which there is no direct sanction in the New Testament.

"Not many years ago, at Whittlesford, seven miles from Cambridge, forty-eight persons were baptised in that ford of the river from which the village takes its name. At ten o'clock, of a very fine morning in May, about 1500 people of different ranks assembled together. At half past ten in the forenoon, the late Dr. Andrew Gifford, Fellow of the Society of Antiquaries, Sublibrarian of the British Museum, and Teacher of a Bapsist Congregation in Eagle-street, London, ascended a moveable pulpit, in a large open court-yard, near the river, and adjoining to the house of the lord of the manor. Round him stood the congregation; people on horseback, in coaches and in carts, formed the outside semicircle; many other persons sitting in the rooms of the house, the sashes being open, all were uncovered, and there was a profound silence. The doctor first gave out a hymn, which the congregation sung. Then he prayed. Prayer ended, he took out a New Testament, and read his text. "I indeed baptise you with water unto repentance." He observed, that the force of the preposition had escaped the notice of the translators, and that the true reading was—'I indeed baptise or dip you in water, at or upon repentance;' which sense he confirmed by the 41st verse of the 12th of Matthew, and other passages. Then he spoke as most Baptists do on these occasions, concerning the nature, subject, mode, and end of this ordinance. He closed, by contrasting the doctrine of infant sprinkling with that of believers' baptism, which, being a part of Christian obedience, was supported by divine promises, on the accomplishment of which all good men might depend. After sermon, he read another hymn, and prayed, and then came down. Then the candidates for baptism retired to prepare themselves. About half an hour after, the administrator, who that day was a nephew of the doctor's, and admirably qualified for the work, in a long black gown of fine baize, without a hat, with a small New Testament in his hand, came down to the river side, accompanied by several Baptist ministers and deacons of their churches, and the persons to be baptised. The men came first, two and two, without hats, and dressed as usual, except that instead of coats, each had on a long white baize gown, tied round the waist with a sash. Such as had no hair, wore white cotton or linen caps. The women followed the men, two and two, all dressed neat, clean, and plain, and their gowns white linen or dimity. It was said, that the garments had knobs of lead at the bottom to make them sink. Each had a long light silk cloak hanging loosely over her shoulder, a broad ribband tied over her gown beneath the breast, and a hat on her head. They all ranged themselves around the administrator at the water side. A great number of spectators stood on the bank of the river on both sides; some had climbed and sat on the trees; many sat on horseback and in carriages, and all behaved with a decent seriousness, which did honour to the good sense and the good manners of the assembly, as well as to the free constitution of this country. First the administrator read an hymn, which the people sung; then he read that portion of scripture which is read in the Greek church on the same occasion, the history of the baptism of the eunuch, beginning at the 23d verse, and ending with the 39th. About ten minutes he stood expounding the verses, and then taking one of the men by the hand, he led him into the water, saying as he went, 'see here is water, what doth hinder? If thou believest with all thine heart, thou mayest be baptized.' When he came to a sufficient depth, he stopped, and with the utmost composure, placing himself on the left hand of the man, his face being towards the man's shoulder, he put his right hand between his shoulders behind, gathering into it a little of the gown for hold: the fingers of the left hand he thrusted under the sash before, and the man putting his two thumbs into that hand, he locked all together by closing his hand. Then he deliberately said, 'I baptise thee in the name of the Father, and of the Son, and of the Holy Ghost;' and while he uttered these words, standing wide, he gently leaned him backward and dipped him once. As soon as he had raised him, a person in a boat fastened there for the purpose, took hold of the man's hand, wiped his face with a napkin, and led him a few steps to another attendant, who then gave his arms, walked with him to the house, and assisted him to dress. There were many such in waiting, who, like the primitive susceptors, assisted during the whole service. The rest of the men followed the first, and were baptized in like manner. After them, the women were baptised. A female friend took off at the water side the hat and cloak. A deacon of the church led one to the administrator, and another from him; and a woman at the water side took each as she came out of the river, and conducted her to the apartment in the house, where they dressed themselves. When all were baptised, the administrator coming up out of the river, and standing at the side, gave a short exhortation on the honour and the pleasure of obedience to divine commands, and then with the usual benediction dismissed the assembly. About half an hour after, the men newly baptised, having dressed themselves, went from their room into a large hall in the house, where they were presently joined by the women, who came from their apartments to the same place. Then they sent a messenger to the administrator, who was dressing in his apartment, to inform him they waited for him. He presently came, and first prayed for a few minutes, and then closed the whole by a short discourse on the blessings of civil and religious liberty, the sufficiency of scripture, the pleasures of a good conscience, the importance of a holy life, and the prospect of a blessed immortality. This they call a public baptism."

The baptists in England form one of the three denominations of protestant dissenters, and are divided into Particular and General: the former are Calvinistical and Trinitarians; the latter are Arminians, and some very few Arians, but the greater part are Unitarians, with regard to the person of Christ, considering him as man, the son of Joseph and Mary.

BAR, in courts of justice, an inclosure made with a strong partition of timber, where the counsel are placed to plead causes. It is also applied to the benches, where the lawyers or advocates are seated, because anciently there was a bar to separate the pleaders from the attornies and others. Hence, our lawyers, who are called to the bar or licensed to plead, are termed barristers, an appellation equivalent to licentiate in other countries.

Bar, in law, a plea of a defendant, which is said to be sufficient to destroy the plaintiff's action. It is divided into bar special, bar to common intendment, bar temporal, and bar perpetual. Bar special, falls out upon some special circumstances of the case in question, as where an executor, being sued for his testator's debt, pleads that he had no goods in his hands at the day on which the writ was sued out. Bar to common intendment, is a general bar, which commonly disables the plaintiff's declaration. Bar temporary is such as is good for the present, but may afterwards fail; and bar perpetual, is that which overthrows the plaintiff's action for ever. In personal actions, once barred, and ever so, is the general rule; but it is intended, where a bar is to the right of the cause, not where a wrong action is brought. In criminal cases, there are especially four pleas in bar, which go to the merits of the indictment, and give reason why the prisoner ought not to answer it, nor be tried upon it; as a former acquittal, a former conviction, although no judgment were given, a former attainder, and a pardon.

Bar, in heraldry, an ordinary in form of the fesse, but much less.

It differs from the fesse only in its narrowness, and in this, that the bar may be placed in any part of the field, whereas the fesse is confined to a single place.

Bar, in music, a stroke drawn perpendicularly across the lines of a piece of music, including between each two a certain quantity or measure of time, which is various, as the time of the music is either triple or common. In common time, between each two bars is included the measure of four crotchets; in triple, three. The principal use of bars is, to regulate the beating of time in a concert.

Bar, *double*, consists of two parallel straight lines, somewhat broader than a common bar, drawn near each other, and passing perpendicularly through the stave. The double bar divides the different strains of a movement. If two or more dots are placed on one of its sides, they imply that the strain of the movement, or the same side with the dots, is to be performed twice; and if the dots are placed on each side of the double bar, the repetition extends to the strains on each side of the double bar.

Bar, in hydrography, denotes a bank of sand, or other matter, whereby the mouth of a river is in a manner choked up.

The term bar is also used for a strong beam, wherewith the entrance of an harbour is secured; this is more commonly called boom.

BARALIPTON, among logicians, a term denoting the first indirect mode of the first figure of syllogism. A syllogism in baralipton, is when the two first propositions are general, and the third particular, the middle term being the subject in the first proposition, and the predicate in the second. Thus,

Ba Every evil ought to be feared:
Ra Every violent passion is an evil:
Lip Therefore something that ought to
be feared is a violent passion.

BARBA, in botany, *a beard*, a species of down with which the surface of some plants is covered. The term was invented by Linnæus, without precise explanation; it seems however to signify a tuft of hairs terminating the leaves.

BARBACAN, or Barbican, an outer defence or fortification to a city or castle, used especially as a fence to the city, or walls; also, an aperture made in the walls of a fortress, to fire through upon the enemy. It is also used as a watch-tower, to descry the approach of the enemy; and it sometimes denotes a fort at the entrance of a bridge, or the outlet of a city having a double wall with towers.

BARBACENIA, in botany, a genus of the Hexandria Monogynia class and order. Calyx superior; six-toothed; corol six-petalled; filaments petal-shaped, toothed; capsule glandular, three-valved, many-seeded. Only one species, found at Brazil.

BARBADOES *tar*, a mineral fluid of the nature of the thicker fluid bitumens, of a nauseous, bitterish taste, very strong and disagreeable smell, found in many parts of America trickling down the sides of the mountains, and sometimes floating on the surface of the waters. It has been greatly recommended in coughs, and other disorders of the breast and lungs.

BARBARA, among logicians, the first mode of the first figure of syllogisms.

A syllogism in barbara, is one whereof all the propositions are universal and affirmative; the middle term being the subject of the first proposition, and attributed in the second. For example,

Bar Every wicked man is miserable;
Ba All tyrants are wicked men;
Ra Therefore all tyrants are miserable.

BARBE, in the military art; to fire in barbe, means to fire the cannon over the parapet, instead of firing through the embrasures; in which case the parapet must not be above three feet and a half high.

BARBED *and crested*, in heraldry, an appellation given to the combs and gills of a cock, when particularized for being of a different tincture from the body.

A barbed cross is a cross, the extremities of which are like the barbed irons used for striking of fish.

BARBEL. See Cyprinus.

BARBER, one who makes a trade of shaving the beards and heads of men, and of making wigs, &c. Formerly the business of a surgeon was united to that of a barber, and he was denominated a barber-surgeon. This union of profession was dissolved by a statute of Henry VIII. by which the surgeons were formed into a distinct corporation, that existed till the late establishment of "The Royal College of Surgeons of London." In England a musical instrument was part of the furniture of a barber-surgeon's shop, which was used by persons above the ordinary level of life, who resorted thither for the cure of wounds, for bleeding, or trimming, a word that signified shaving, and cutting, or curling the hair. Bleeding and tooth-drawing are now very commonly practised in country places by barbers, and the pole stuck out as the sign of their profession is supposed to indicate the staff which is held in the patient's hand during the act of bleeding, and the fillet with which it is wound is tied up after the operation is completed.

BARBERRY, in botany. See **Berberis.**

BARD, a poet among the ancient Gauls and Britons, who celebrated the praises of heroes, with a view to inculcate virtue, and sometimes to terminate a difference between two armies at the point of engagement. It is disputed in what the bards differed from the Druids; some pretend that these were the priests and philosophers of the nation, and that those were only the poets and historians; but it is more probable that Druid was a general word, comprehending the priests, the judges, the instructors of youth, and the bards or poets. See **Druid.**

The bards were not only the poets, but the genealogists, biographers, and historians of those countries and ages. The ganealogical sonnets of the Irish bards are still the chief foundations of the ancient history of Ireland. It was customary for the bards to sing these compositions in the presence of their nobles, and at their chief festivals and solemnities. In the Highlands of Scotland there are bards still in being, and considerable remains of many of the compositions of the old British bards still preserved; but the most genuine, entire and valuable remains of the works of the ancient bards, and perhaps the noblest specimen of uncultivated genius, if not the most sublime fragments of ancient poetry now extant, are the poems of Ossian the son of Fingal, a king of the Highlands, who flourished in the second or third century, lately collected by Mr. Mac-Pherson, and by him translated from the Erse or Gaelic language into English.

The reputation, influence, and power of this order of men were formerly very high, they were courted by the great, and seated at the tables of princes. Their power in exciting the courage and rousing the fury of armies is universally recorded, and generals have often confessed themselves indebted for victory to their heroic strains. They were not unfrequently chosen negotiators with the enemy, and the deeds of the day were in the evening recorded in their songs; and the fame of their fallen heroes perpetuated by their praise.

BARGAIN, in commerce, a contract or agreement in buying and selling. Hence, to buy a good bargain is to buy cheap.

Bargain is also an agreement to give a certain price; and there are three things requisite to make it complete and perfect. 1. The merchandize sold. 2. The price 3. The mutual agreement or consent.

The merchandize sold ought to be certain, the price of the thing sold should be paid in current money, otherwise it would be an exchange; and the consent ought to be equally free, on both sides, from error and violence. If then there happens to be an error in the substance of the thing bought, it makes the bargain void; but if it lies only in the quality of the thing sold, it does not dissolve the bargain, provided there be no voluntary fraud on the side of the seller. Thus, if I design to buy pewter, and instead of that, the person sells me lead, the sale cannot stand good, because I was imposed upon in the very substance of the thing I wanted to buy. But if I designed to buy a clock that went true, and it does not prove so, the bargain ought to stand, because I was deceived in the qualities only of the thing sold to me.

A bargain and sale of lands, &c. in fee, must, according to our law, be in writing, indented, and enrolled either in one of the courts at Westminster, or in the county where the lands lie, before the custos rotulorum, and justices of peace. A warrant and covenant may be inserted in a bargain and sale, but the deed is good without any such addition; and if it be made for money and natural affection, the estate will pass, though you do not enrol it.

BARGE, in naval affairs, a boat of state and pleasure, adorned with various ornaments, having bales and tilts, and seats covered with cushions and carpets, and benches for many oars; as a company's barge, an admiral's barge, &c. It is also the name of a flat-bottomed vessel employed for carrying goods in a navigable river, as those upon the river Thames, called west country barges.

BARILLA, in the arts, is an alkaline substance, prepared principally in Spain and Italy from sea plants, which are there cultivated for the purpose. The discovery of the use of these plants was made by the Saracens in Spain, who called the particular plant from which they extracted it kali, which, with the addition of the Arabian article *al*, gave rise to the term alkali. The barilla is obtained by cutting down the plant when it has attained its full height, and drying it; after which it is burnt, and during the operation the ashes harden into lumps or cakes. This country is supplied with barilla, chiefly from Spain, the Island of Teneriffe, and Sicily.

It is used by glass-makers, soap-boilers, bleachers, and in other manufactures.

BARK, in vegetable anatomy, a term which denotes the exterior part of vegetable bodies; which is separable from the other parts of the plant during the season of vegetation, but at other times requires maceration in water, or boiling; and when detached by any of these means, the fine connections which unite it to the wood are destroyed. When bark is thus separated, and seen by means of the microscope, it exhibits parts differing much in structure and use. These have been divided into the cuticle or epidermis, the cellular envelope or parenchyma, and the cortical layer and liber. The epidermis is a thin transparent membrane, which covers all the outside of the bark. It is pretty tough. When inspected with a microscope, it appears to be composed of a number of slender fibres, crossing each other, and forming a kind of network. It seems even to consist of different thin retiform membranes, adhering closely together. This, at least, is the case with the epidermis of the birch, which Mr. Duhamel separated into six layers. The epidermis, when rubbed off, is reproduced. In old trees it cracks and decays, and new epidermis are successively formed. This is the reason that the trunks of many old trees have a rough surface. The parenchyma lies immediately below the epidermis; it is of a deep green colour, very tender and succulent. When viewed with a microscope, it seems to be composed of fibres which cross each other in every direction, like the fibres which compose a net. Both in it and the epidermis there are numberless interstices, which have been compared to so many small bladders. The cortical layers form the innermost part of the bark, or that which is next to the wood. They consist of several thin membranes, lying the one above the other; and their number appears to increase with the age of the plant. Each of these layers is composed of longitudinal fibres, which separate and approach each other alternately, so as to form a kind of net-work. The meshes of this net-work correspond in each of the layers; and they become smaller and smaller in every layer as it approaches the wood. These meshes are filled with a green-coloured cellular substance, which has been compared by anatomists to a number of bladders adhering together, and communicating with each other.

The matter of the parenchyma, and the juices which exist in barks, vary extremely, and probably occasion most of the differences between them. Some, as oak bark, are characterized by their astringency, and contain tannin; others, as cinnamon, are aromatic, and contain an essential oil; others are bitter, as Jesuit's bark; some are chiefly mucilaginous, others resinous, &c.

1. Bark of the cinchona floribunda, or quinquina of St. Domingo. This bark is in rolled pieces, six or seven inches long, and three or four lines in thickness. Its colour is greyish green externally, but within it exhibits different shades of green, purple, white, brown, &c. Its taste is bitter and disgreeable; its odour strong and unpleasant. It gives out nearly half its weight to water, provided it be boiled in a sufficient quantity of that liquid. The residue possesses the properties of woody fibre. The decoction of the bark has a reddish brown colour, and an extremely bitter taste. It deposits on cooling a blackish substance, soft and tenacious, which does not dissolve in cold water, though it is soluble in hot water and in alcohol. More of this substance precipitates as the liquor is evaporated. When the inspissated juice, freed from its precipitate, is mixed with alcohol, a quantity of gummy matter separates. When the black matter, which precipitates as the decoction cools, is treated with hot alcohol, the greatest part of it is dissolved; but a fine red powder remains mixed with some mucilage, which is easily separated by water. When the alcoholic solution is exposed to the air, it deposits light yellowish crystals of a saline nature. When mixed with water, white flakes are thrown down, which possess the properties of gluten; but the greatest part remains in solution. Thus the soluble part of the bark may be separated into five distinct substances; namely, gum, gluten, a red powder, a saline matter, and a brownish bitter substance, retained in solution by the diluted alcohol. The last is by far the most abundant. To it the peculiar qualities of the decoction of this bark are to be ascribed.

2. Bark of cinchona officinalis. This tree grows in Quito; it is confined to the high grounds, and when stripped of its bark soon dies. There are three different kinds of bark to be found in commerce, but whether they be all obtained from the same trees is not known; the contrary is probable. The following are the most remarkable of these varieties. Red Peruvian bark.—This bark is usually in large pieces, and is reducible to powder with more ease than the preceding. Its pow-

der is reddish brown, and has a slightly bitter taste, with a good deal of astringency. Yellow Peruvian bark.—This species of bark, first brought into use in this country about the year 1790, has not yet been subjected to a rigorous analysis; but its constituents do not appear, from the trials which have been made, to differ much from those of the red species. Pale Peruvian bark.—This is the common variety of the bark. It has not yet been subjected to a correct chemical analysis. Its taste is astringent and bitter, and very disagreeable. It is supposed to contain a bitter principle, tannin, extractive, and resin. Besides these, it contains a principle first pointed out by Seguin, and upon which Dr. Duncan, junior, published some experiments. It is distinguished by the property of precipitating infusion of galls; but as this property is common to a considerable number of substances, it is not sufficient alone to characterize it.

3. Bark of cinchona caribæa.—This bark was first made known by Dr. Wright, who published a botanical description of the tree, with a figure, in the Philosophical Transactions, vol. 67, and an account of the medicinal properties of the bark in the London Medical Journal for 1787. A description of a tree to which the same name is given, together with a chemical analysis of the bark, was published in the Journal de Physique for 1790, by M. Vavasseur; but it is not quite certain that the plants are the same.

4. Bark of the white willow (salix alba).—The bark of this tree, which is common enough in Scotland, is remarkable for its astringent taste, and has been often used in intermittents by the common people. It has lately been proposed by Bouillon la Grange as an excellent substitute for Peruvian bark; being composed, according to him, of the very same constituents to which that bark owes its medical virtues. A very superficial examination, however, may satisfy any one, that the properties of the two are very far from similar.

5. Bark of quercus nigra.—This tree, to which the name of quercitron has been given, grows spontaneously in North America. Dr. Bancroft discovered, about the year 1784, that the inner bark of this tree contains a great quantity of colouring matter; and since that time it has been very generally used by the dyers. To prepare it for them, the epidermis (which contains a brown colouring matter) is shaved off, and then the bark is ground in a mill. It separates partly into stringy filaments, and partly into a fine light powder.

Bark, or *Jesuit's bark*, is a name given by way of eminence to the cinchona. See Materia Medica and Pharmacy.

Bark, in navigation, a little vessel with two or three triangular sails; but, according to Guillet, it is a vessel with three masts, *viz.* a main-mast, fore-mast, and mizen-mast. It carries about two hundred tons.

BARKING *of trees*, the peeling off the rind or bark, which must be done, in our climate, in the month of May, because at that time the sap of the tree separates the bark from the wood. It would be very difficult to perform it at any other time of the year, unless the season was extremely wet and rainy, for heat and dryness are a very great hindrance to it.

BARLERIA, in botany, so named in honour of James Barrelier, a Dominican, whose Icones were published in 1714, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Acanthi, Jussieu. Essential character: calyx four-parted; stamens two, far less than the others; capsule quadrangular, bilocular, bivalval, elastic; without the claws; seeds two. There are eleven species, and being all natives either of the East Indies or South America, require the protection of the bark-stove.

BARLEY, in botany. The principal use of barley in this country is for making beer; but, in seasons like the present, when peas are very scarce, large quantities of it are used in feeding hogs. In Scotland, barley is a common ingredient for broths; it is also much used for the same purpose in England, at the tables of persons of rank. In some parts of the continent, horses are fed with barley. Pearl barley, and French barley, are barley freed from the husk by means of a mill, the distinction between the two being, that pearl barley is reduced to the size of very small shot, all but the heart of the grain being ground away. See Hordeum.

Barley, in chemistry, is the seed of the hordeum vulgare, which will be described hereafter. Great crops of it are reared annually, partly as an article of food, and partly as a material from which malt liquors and ardent spirits are drawn. This species of corn has been examined of late with considerable attention by chemists, partly in order to form correct conceptions, if possible, of the nature of the process of fermentation; and partly to ascertain the constituents of barley. Fourcroy and Vauquelin published several ingenious remarks and experiments on it in 1806, and Einhof published a still more elaborate analysis about the commencement of the same year, having examined this grain in different stages of its growth, and after it was fully ripe. When unripe barley-corns are triturated with water, the liquid acquires a milky colour. If this process be continued, adding fresh portions of water as long as the liquid passes off muddy, there remains only a green husky matter. When this matter is macerated a sufficient time in cold water, it acquires a greenish grey colour, and when dry has the appearance of vegetable fibre. The water in which it was macerated, when boiled, deposits a few flakes of albumen, and when evaporated to dryness, leaves a small portion of extractive. The water with which the barley was at first triturated is at first milky, and gradually deposits a white powder; yet it does not become transparent, though allowed to stand a considerable time. When filtered, it passes through transparent, while a slimy substance, of a greenish grey colour, remains upon the filter. This substance possesses the properties of gluten. When the solution, now transparent, and of a yellowish colour, is boiled, it deposits flakes of albumen. It reddens litmus paper, and is strongly precipitated by lime-water, nitrate of lead, and sulphate of iron, indicating the presence of phosphoric salts. The liquid being evaporated to the consistence of a syrup, and the residue treated with alcohol, the solution diluted with water, and the alcohol distilled off, to separate some gluten which still remained, a syrupy matter was obtained, having a sweet taste, which was considered as the saccharine matter of the barley. A portion refused to dissolve in alcohol. This portion was considered as extractive. The white powder, which precipitated from the water in which the barley had been originally triturated, possessed the properties of starch.

Barley-*corn*, the least of our long measures, being the third of an inch.

BARLOWE, (William) in biography, an eminent mathematician and divine, was born in Pembrokeshire, his father, (William Barlowe) being then bishop of St. David's. In 1560 he was entered commoner of Baliol College in Oxford; and in 1564, having taken a degree in arts, he left the university, and went to sea, where he acquired considerable knowledge in the art of navigation, as his writings afterwards shewed. About the year 1573, he entered into orders, and obtained much and valuable preferment, and at length was appointed chaplain to Prince Henry, eldest son of King James the First; and, in 1614, archdeacon of Salisbury. Barlowe was remarkable, especially, for having been the first writer on the nature and properties of the loadstone, 20 years before Gilbert published his book on that subject. He was the first who made the inclinatory instrument transparent, and to be used with a glass on both sides. It was he also who suspended it in a compass box, where, with two ounces weight, it was made fit for use at sea. He also found out the difference between iron and steel, and their tempers for magnetical uses. He likewise discovered the proper way of touching magnetical needles; and of piercing and cementing of loadstones; and also why a loadstone, being double-capped, must take up so great a weight. He died in the year 1625. His works are numerous and respectable.

BARM, otherwise called *Yeast*, the head or workings out of ale or beer.

BARNACLE, in ornithology, a species of goose with a black beak, which is much shorter than in the common goose. See Anas.

Barnacle is also a species of shell-fish, otherwise called concha anatifera. See the article Concha.

Barnacles, in farriery, an instrument composed of two branches joined at one end with a hinge, to put upon horses' noses when they will not stand quietly to be shod, blooded, or dressed.

BARNADESIA, in botany, so called from Michael Barnades, a Spanish botanist, a genus of the Syngenesia Polygamia Æqualis class and order; natural order of Compositæ Discoidæ; Corymbiferæ, Juss. Essential character: calyx naked, imbricate, pungent; corolla radiate. Down of the ray feathered; of the disk, bristly, broken backwards. There is only one species, B. Spinosa, a shrub with very smooth branches, set with a pair of thorns at their origin, which at first were stipules; they are patulous, brown, and smooth. It is a native of South America.

BAROCO, in logic, a term given to the fourth mode of the second figure of syllogisms. A syllogism in baroco has the first proposition universal and affirmative, but the second and third particular are negative, and the middle term is the predicate in the two first propositions. For example:

Nullus homo non est bipes:
Non omne animal est bipes:
Non omne animal est homo.

BAROMETER, an instrument for measuring the weight or pressure of the atmosphere; and by that means the variations in the state of the air, foretelling the changes in the weather, and measuring heights or depths, &c. About the beginning of the 17th century, when the doctrine of a plenum was in vogue, it was a common opinion among philosophers, that the ascent of water in pumps was owing to what they called nature's abhorrence of a vacuum; and that thus fluids might be raised by suction to any height whatever. But an accident having discovered that water could not be raised in a pump, unless the sucker reached to within 33 feet of the water in the well, it was conjectured by Gallileo, who flourished about that time, that there might be some other cause of the ascent of water in pumps, or at least that this abhorrence was limited to the finite height of 33 feet. Being unable to satisfy himself on this head, he recommended the consideration of the difficulty to Torricelli, who had been his disciple. After some time Torricelli fell upon the suspicion, that the pressure of the atmosphere was the cause of the ascent of water in pumps; that a column of water 33 feet high was a just counterpoise to a column of air of the same base, and which extended up to the top of the atmosphere; and that this was the true reason why the water did not follow the sucker any farther. And this suspicion was soon after confirmed by various experiments. See ATMOSPHERE.

It was some time, however, before it was known that the pressure of the air was various at different times in the same place. This could not, however, remain long unknown, as the frequent measuring of the column of mercury must soon shew its variations in altitude; and experience and observation would presently shew that those variations in the mercurial column were always succeeded by certain changes in the weather, as to rain, wind, frosts, &c.: hence this instrument soon came into use as the means of foretelling the changes of the weather, and on this account it obtained the name of the weather-glass, as it did that of barometer, from its being the measurer of the weight or pressure of the air. We may now proceed to take a view of its various forms and uses.

The common mercurial barometer, (plate Miscel. fig. 9.) or weather-glass, is a cylindrical glass tube, whose diameter is generally about one-third or one-fourth of an inch in diameter, and length 34 inches, filled with prepared mercury; one end of the tube, A, is hermetically sealed, and the open end, B, inserted into a basin of mercury. The tube and basin are fixed to a frame of wood, and suspended in a vertical situation. The height of the mercury in the tube above the surface of the mercury in the basin is called the standard altitude, and the difference between the greatest and least altitudes is called the limit or scale of variation.

The mercury in the barometer tube will subside, till the column be equivalent to the weight of the external air upon the surface of the mercury in the basin, and it is therefore a criterion to measure that weight, and chiefly directed to that purpose. In this kingdom the standard altitude fluctuates between 28 and 31 inches; and from hence it is justly inferred, that the greatest, least, and intermediate weights of the atmosphere upon a given base are respectively equal to the weights of columns of mercury upon the same base, whose vertical altitudes are 28, 31 inches, and some altitude contained between them.

The standard altitude ought to be the same, whatever be the diameter of the barometer tube: but when this diameter is very small, the attraction of cohesion between the mercury and glass prevents a variation of altitude, which ought to be, and in larger tubes is, sensible from small differences in the weight of the atmosphere.

Writers on this subject have given the following lemma:—If a given line, L, be divided into n equal parts, and $L \times \frac{n+m}{n}$ be also divided into n equal parts, each division of L will be less than that of $L \times \frac{m+m}{n}$ by $L \times \frac{m}{n^2}$.

When L is divided into n equal parts, each part is equal to $L \times \frac{1}{n}$, or $L \times \frac{n}{n^2}$; and each part of $L \times \frac{n+m}{n}$, thus divided, is equal to $L \times \frac{n+m}{n^2}$, which is greater than the former by $L \times \frac{m}{n^2}$.

If each inch of the scale of variation, A D. (fig. 10.) of a barometer tube be divided into ten equal parts, marked with 1, 2, 3, &c. increasing upwards, and a vernier or nonius, L M, whose length is $\frac{11}{10}$ths of an inch, be divided into ten equal parts, marked with 1, 2, 3, &c. increasing downwards, and so placed as to slide along the graduated scale of the barometer, the altitude of the mercury in the tube above the surface of that in the basin may be found in inches and hundredth parts of an inch in this process. If the surface of the mercury in the tube do not coincide with a division in the scale of variation, place the index of the vernier, M, even with the surface, and observing where a division of the vernier coincides with one in the scale, the figure in the vernier will shew what hundredth parts of an inch are to be added to the tenths immediately below the index. Let, for instance, the surface of the mercury be between 7 and 8 tenths above 30 inches, and the index of the vernier being placed even with it, and the figure 5 upon the vernier being observed to coincide with a division upon the scale, the altitude of the barometer will be 30 inches and five hundredths of an inch: for each division of the vernier being greater than that of the scale by one hundredth of an inch (lemma), and there being five divisions, the whole must be five hundredths of an inch above the number 7 in the scale, and the height of the mercury is therefore 30.75 inches.

Whatever be the number of divisions in the scale of variation, and in the vernier, the height of the mercury in the barometer is easily discovered by a process similar to that already mentioned.

There are several other kinds of barometers, of which it will be sufficient to give a short description.

1. In the portable barometer, the lower part of the tube is bent upwards and wider than the rest of the tube: and in this recurvated part the mercury is exposed to the pressure of the atmosphere; or the mercury in the basin is contained in a flexible leathern bag, exposed to the same pressure. In this last, the mercury is forced into the tube so as to fill it, by a screw fixed in the bottom of a wooden box containing the bag, lest the motion of the mercury should break the tube.

2. In the diagonal barometer, (fig. 11) the scale of variation is bent into the direction D R, making an obtuse angle with the vertical part B D. The scale of variation is by this barometer increased in the ratio of D R : D A; but this increase does not compensate for the friction and attraction of cohesion upon the lower side of D R. And when the angle R D A is greater than 45°, the instrument is rendered useless by the separation of globules of mercury from the column.

3. The wheel-barometer, (fig. 12) is a compound tube, S E R B D, open at D and closed at E, the diameter of the highest part, S E R, being much greater than that of the rest, and filled with mercury from D to S R, and above that vacuous. Upon the surface of the mercury, in the recurved leg, there is an iron ball in equilibrio with another, H, by a string passing over a pully, P. As the ball at D rises and falls with the mercury, the string turns the pully, and an index, I N, fixed to it, which points to different parts of a graduated circle. It is clear, that by increasing the diameter of the circle, this contrivance will shew the minutest variations of the air, provided the friction be inconsiderable, which is seldom true.

4 The pendent barometer, (fig. 13) is composed of a tube of a very small bore, a little conical or tapering, closed at the smaller orifice, A, and filled with prepared mercury from A to B, whose distance is equal to the greatest altitude, or about 31 inches. Let the tube be suspended vertically, and the mercury will subside, and be quiescent in that part whose length is equal to the standard altitude at that time: and supposing that to be the least, it will occupy a space F E equal to 28 inches; and consequently A F is the scale of variation. If A E = 60 inches, then A F = 32, when in the common barometer it is only 3 inches. The diameter of this barometer tube is very small, and consequently the attraction of cohesion considerable, which prevents the freedom of motion necessary to ascertain minute variations of the air's pressure.

5. In the horizontal rectangular barometer, (fig. 14) the highest part of the tube, opposite to the scale of variation, is wider than the rest of the tube; and the mercury descending three inches from A to D, will describe a much longer space in the horizontal leg F G, these spaces being to each other inversely as the squares of the diameters of the tubes, and that F G being very small, its motion will be extremely sensible. But the free motion of the mercury in F G is impeded by friction, and the attraction of cohesion, which, from the smallness of the tube, is considerable; and besides this,

globules of mercury are apt to be separated from M, and flow out at G.

By the above, and other expedients, as using water, or water and mercury, the scale of variation is enlarged; but the common barometer is the best, being subject to the fewest inconveniences. In the construction and use of it, the following particulars are to be observed. 1. The diameter of the tube should be one-third or one-fourth of an inch, to prevent the effects of the attraction of cohesion; the length of the tube 33 or 34 inches, with a bulb upon the top, into which the air may be diffused, should any remain in the mercury. 2. The diameter of the cistern, containing the mercury, should be large, (at least ten times greater than that of the tube) that the addition or subtraction of the mercury, contained between the greatest and least altitudes, may not sensibly affect its depth; for the numbers, marked upon the side of the tube, shew their distance from a fixed point, and cannot shew the height of the column above the mercury in the cistern, unless its surface coincide with this point, and be immoveable. 3. The mercury should be free from any mixture of other metals, and purged of air, by being boiled in a glazed earthen vessel, closely covered, and poured, when hot, through a glass funnel, with a long capillary tube, into the barometer tube, washed with a rectified spirit, and cleaned with a piston of shammy leather, if both ends were not hermetically sealed when it was made, and heated and rendered electrical by rubbing. 4. Unless the temperature of the air remain the same, the dimensions of a given quantity of mercury will be variable, and the altitude of the mercury is an uncertain measure of the weight of the atmosphere, because it is dilated by heat, and contracted by cold, when perhaps the weight of the atmosphere is unaltered. If very great exactness be therefore required, the difference of temperature, at the different times of observation, and the depression or elevation of the mercury produced by it, must be ascertained, before the height of the column, raised by the weight of the atmosphere, can be discovered. See WEATHER, *rules for judging of.*

The barometer applied to the measuring of altitudes.—The secondary character of the barometer, namely, as an instrument for measuring accessible heights or depths, was first proposed by Pascal and Descartes, and succeeding philosophers have been at great pains to ascertain the proportion between the fall of the barometer and the height to which it is carried; as Halle, Mariotte, Shuckburgh, Roy, and more especially by De Luc, who has given a critical and historical detail of most of the attempts that have at different times been made for applying the motion of the mercury in the barometer to the measurement of accessible heights. And for this purpose serves the portable barometer already described, which should be made with all the accuracy possible. Various rules have been given, by the writers on this subject, for computing the height ascended from the given fall of the mercury in the tube of the barometer, the most accurate of which was that of Dr. Halley, till it was rendered much more accurate by the indefatigable researches of De Luc, by introducing into it the corrections of the columns of mercury and air, on account of heat. This rule is as follows: *viz.* $10000 \times \log.$ of $\frac{M}{m}$ is the altitude in fathoms, in the mean temperature of 31°; and for every degree of the thermometer above that, the result must be increased by so many times its 435th part, and diminished when below it: in which theorem M denotes the length of the column of mercury in the barometer tube at the bottom, and m that at the top of the hill, or other eminence; which lengths may be expressed in any one and the same sort of measures, whether feet, or inches, or tenths, &c. and either English, or French, or of any other nation; but the result is always in fathoms, of six English feet each. The following rules must be attended to.

1. Observe the height of the barometer at the bottom of any height or depth proposed to be measured; together with the temperature of the mercury, by means of the thermometer attached to the barometer, and also the temperature of the air in the shade, by another thermometer which is detached from the barometer.

2. Let the same thing be done also at the top of the said height or depth, and as near to the same time with the former as may be. And let those altitudes of mercury be reduced to the same temperature, if it be thought necessary, by correcting either the one or the other, *viz.* augmenting the height of the mercury in the colder temperature, or diminishing that in the warmer, by its 9600th part for every degree of difference between the two; and the altitudes of mercury so corrected are what are denoted by M and m, in the algebraic formula above.

3. Take out the common logarithms of

the two heights of mercury, so corrected, and subtract the less from the greater, cutting off from the right-hand side of the remainder three places for decimals; so shall those in the left be fathoms in whole numbers, the tables of logarithms being understood to be such as have seven places of decimals.

4. Correct the number last found, for the difference of the temperature of the air, as follows: *viz.* take half the sum of the two temperatures of the air, shewn by the detached thermometers, for the mean one; and for every degree which this differs from the standard temperature of 31°, take so many times the 435th part of the fathoms above found, and add them, if the mean temperature be more than 31°, but subtract them, if it be below 31°; so shall the sum or difference be the true altitude in fathoms, or, being multiplied by 6, it will give the true altitude in English feet.

Ex. 1. Let the state of the barometers and thermometers be as follows, to find the altitude; *viz.*

Thermometers.		Barometers.
detached.	attached.	
57	57	29.68 lower
42	43	25.28 upper
mean 49½	dif. 14	

As 9600 : 14 : : 29.68 : .04
cor. .04 logs.
mean 49½ M = 29.64 - 4718782
stand. 31 m = 25.28 - 4027771
dif. 18½ As 435 : 18½ : : 691011 : 29.388
29.388
the altitude sought is { 720.399 fath. or 4322.394 feet.

Ex. 2. To find the altitude of a hill, when the state of the barometer and thermometer, as observed at the bottom and top of it, is as follows; *viz.*

Thermometers.		Barometers.
detached.	attached.	
35	41	29.45
31	38	26.82
mean 33	dif. 3	

As 9600 : 3 : : 29.45 : .01
.01 logs.
mean 33 M = 29.44 - 4689378
stand. 31 m = 26.82 - 4284588
dif. 2 As 435 ·2 :: 404.790 : 1.86
1.86
the altitude sought is { 406.65 fathoms. or 2439.93 feet.

The mean height of the barometer in London upon an average of two observations in every day in the year, kept at the house of the Royal Society for many years past, is 29.88; the medium temperature, or height of the thermometer, according to the same, being 58°. But the medium height at the surface of the sea, according to Sir Geo. Shuckburgh, is 30.04 inches, the heat of the barometer being 55°, and of the air 62°. See PNEUMATICA.

BARON, in British customs, a degree of nobility next to a viscount, but the highest in point of antiquity. In the House of Peers, dukes, marquisses, earls, viscounts, and barons, are all equal members, whence they are collectively called a House of Peers, or equals; but, in other respects, they claim and enjoy certain honours and distinctions, peculiar to their respective ranks and the date of their creations. See PRECEDENCE.

The original, by writ, Camden refers to King Henry III. and barons, by letters patent or creation, commenced in the reign of Richard II. to these is added a third kind of barons, called barons by tenure. The chief burgesses of London were in former times barons, before there was a lord-mayor; the earl-palatines had anciently their barons under them; but no barons, except those who held immediately under the king, were peers of the realm.

BARONS *of the exchequer*, the four judges to whom the administration of justice is committed, in causes between the king and his subjects, relating to matters concerning the revenue. They were formerly barons of the realm, but of late are generally persons learned in the laws. Their office is also to look into the accounts of the king, for which reason they have auditors under them.

BARON *and feme*, in our law, a term used for the husband in relation to his wife, who is called feme; and they are deemed but one person, so that a wife cannot be witness for or against her husband, nor he for or against his wife, except in cases of high treason.

BARON *and feme*, in heraldry, is when the coats of arms of a man and his wife are borne per pale in the same escutcheon, the man's being always on the dexter side, and the woman's on the sinister; but here the woman is supposed not an heiress, for then her coat must be borne by the husband on an escutcheon of pretence.

BARONS *of the Cinque-ports*, are sixteen members of the House of Commons, elected by the Cinque-ports; two for each port.

BARONET, a modern degree of honour, next to a baron, created by King James I. in order to propagate a plantation in Ulster, in Ireland, for which purpose each of them was to maintain thirty soldiers in Ireland for three years, after the rate of eight pence sterling per day to each soldier. The honour is hereditary, and they have the precedence of all knights, except those of the garter, bannerets, and privy-counsellors. They are stiled baronets in all writs, and the addition of Sir is attributed to them, as the title of Lady is to their wives. No honour is to be created between barons and baronets.

Baronets *of Ireland*, a dignity instituted 30th Sept 1619.

BARONY, the honour and territory which gives title to a baron, whether he be a layman or a bishop. According to Bracton, a barony is a right indivisible; wherefore, if an inheritance is to be divided among co-heirs, though some capital messuages may be divided, yet if the capital messuage be the head of a county or barony, it may not be parcelled; and the reason is, lest by this division many of the rights of counties and baronies by degrees come to nothing, to the prejudice of the realm, which is said to be composed of counties and baronies.

BARRA, in commerce, a long measure, used in Portugal and some parts of Spain, to measure woollen cloths, linen cloths, and serges.

BARRACAN, in commerce, a sort of stuff not diapered, something like camblet, but of a coarser grain. It is used to make cloaks, surtouts, and such other garments, to keep off the rain.

BARRACKS, places for soldiers to lodge in, especially in garrisons. Barracks were formerly reckoned as highly dangerous to the constitution of the realm; within these last ten years, however, they have increased so much in number and extent, that there is scarcely a moderate sized town in the kingdom without its barracks; and one might infer, from the rapid increase of these buildings, that our very existence depends upon them.

BARRATOR, in law, a common mover or maintainer of suits and quarrels, either in courts or elsewhere in the country. A man cannot be adjudged a barrator for bringing any number of suits in his own right, though they are vexatious. Barrators are punished by fine and imprisonment.

BARRATRY, in law, signifies the fomenting quarrels and law-suits.

Barratry, in a ship-master, is his cheating the owners. If goods delivered on ship-board are embezzled, all the mariners ought to contribute to the satisfaction of the party that lost his goods, by the maritime law; and the cause is to be tried in the admiralty. In a case where a ship was insured against the barratry of the master, &c. and the jury found that the ship was lost by the fraud and negligence of the master, the court agreed that the fraud was barratry, though not named in the covenant; but that negligence was not.

BARREL is a measure of liquids. The English barrel, wine measure, contains the eighth part of a tun, the fourth part of a pipe, and one half of an hogshead; that is to say, it contains thirty-one gallons and a half: a barrel, beer-measure, contains thirty-six gallons.

Barrel also denotes a certain weight of several merchandises, which differs according to the several commodities: a barrel of Essex butter weighs one hundred and six pounds; and of Suffolk butter, two hundred and fifty-six pounds. The barrel of herrings ought to contain thirty-two gallons wine-measure, which amount to about twenty-eight gallons old standard, containing about a thousand herrings. The barrel of salmon must contain forty-two gallons. The barrel of eels the same. The barrel of soap must weigh two hundred and fifty-six pounds.

Barrel, *fire*, in military affairs, is mounted on wheels, filled with a composition and intermixed with loaded grenades, and the outside full of sharp spikes: some are placed under ground, to act as mines: others are used to roll down a breach, to prevent the enemy's entrance. These are rarely used now in any country.

Barrel, in mechanics, a term given by watch-makers to the cylinder about which the spring is wrapped; and by gun-smiths to the cylindrical tube of a gun, pistol, &c. through which the ball is discharged.

BARRERIA, in botany, named after Peter Barrere, a French physician, a genus of the Syngenesia Monogynia class and order. Essential character: calyx five toothed, very small; corol five-parted; style short; stigma trifid. There is only one species, *viz.* B. guianensis. This tree rises forty or fifty feet in height, and is two feet and a half in diameter; the bark is ash-coloured, and the wood is reddish brown, hard and compact. It sends forth from the top a great number of branches, which rise and spread in all directions. These branches are loaded with twigs, on which are alternate leaves ending in a point. It is a native of Guiana, and flowers there in November.

BARRICADE, or Barricado, a warlike defence, consisting of empty barrels and such like vessels filled with earth, stones, carts, trees cut down, against an enemy's shot, or assault; but generally trees cut with six faces, which are crossed with battoons as long as a half-pike, bound about with iron at the feet.

In a vessel of war, the vacant spaces between the stancheons are commonly filled with rope, mat, cork, or pieces of old cable, and the upper part, which contains a double rope netting above the sail, is stuffed full with hammocks, to intercept the motion, and prevent the execution of small shot in the line of battle.

BARRIER, in fortification, a kind of fence made at a passage, retrenchment, &c. to stop up the entry thereof, and is composed of great stakes, about four or five feet high, placed at the distance of eight or ten feet from one another, with transums, or over-thwart rafters, to stop either horse or foot, that would enter or rush in with violence: in the middle is a moveable bar of wood, that opens and shuts at pleasure. A barrier is commonly set up in a void space, between the citadel and the town, in half-moons, &c.

BARRINGTONIA, in botany, so named from the Hon. Daines Barrington, a genus of the Monadelphia Polyandria class and order. Natural order Hesperideæ: Myett, Jussieu. Essential character: calyx simple, two-leaved, superior, permanent; fruit a dry four-cornered drupe, inclosing a nut, one to four-celled. There is but a single species, *viz.* B. speciosa, a lofty tree, and the handsomest in the whole equinoxial flora, with its thick shady bunches of leaves, and its large, handsome, purple and white flowers, every where mixed with them. The trunk is lofty, thick, straight; covered with a dark grey, smooth bark, scored with little chinks. The branches are round, expand very widely, subflexuose, variously divided, covered with a chinky bark, and leafy at the ends. The flowers are very large, white, and transparent; the filaments are white, with a purple top, and diaphanous at the base; the anthers are gold coloured; the style white, with a purple top. The flowers open during the night, and fall at sun-rise; the birds also pluck them off, and the ground about these trees is perfectly covered with them. The seed, mixed with the bait, inebriates fish in the same manner with cocculus indicus. It grows within the Tropics, especially on the shores of the ocean, and at the mouths of rivers in the East Indies, from the southern coasts of China through the Molucca Isles to Otaheite, and the other Society Isles, &c. It is cultivated in the governor's garden at the island of St. Helena.

BARRISTER, in common law, a person qualified and empowered to plead and defend the cause of clients in the courts of justice. They are of two sorts, the outward or outer barristers, who, by their long study in, and knowledge of, the law, which must be for a term of seven years at least, are called to public practice, and always plead without the bar. The inner barristers are those, who, because they are either attorney, solicitor, serjeant, or counsel to the king, are allowed, out of respect, the privilege of pleading within the bar. But at the Rolls, and some other inferior courts, all barristers are admitted within the bar.

Barristers, who constantly attend the King's Bench, are to have the privilege of being sued in transitory actions, in the county of Middlesex. The fees to a counsellor are not given as hire, but as a mere gratuity, which a barrister cannot demand, without injuring his reputation.

BARROW (Isaac), a very eminent mathematician and divine, was born at London in October, 1630, being the son of Thomas Barrow, then a linen-draper of that city, but descended from an ancient family in Suffolk. He was at first placed at the Charter-house school for two or three years, where his behaviour afforded but little hopes of success in the profession of a scholar. Being removed to Felsted in Essex, his disposition took a different turn; and having soon made great progress in learning, he was first admitted a pensioner of Peter-House in Cambridge; but when he came to join the university, in February, 1645, he was entered at Trinity College. He now applied himself with great diligence to the study of all parts of literature, especially natural philosophy. He afterwards turned his attention to the profession of physic, and made a considerable progress in anatomy, botany, and chemistry: he next studied divinity, then chronology, astronomy, geometry, and the other branches of the mathematics; with what success, his writings afterwards most eminently shewed.

When Dr. Dupart resigned the chair of Greek professor, he recommended his pupil, Mr. Barrow, for his successor, who, in his probation exercise, shewed himself equal to the character that had been given him by this gentleman; but being suspected of favouring Arminianism, he was not preferred. This disappointment determined him to quit the college, and visit foreign countries; but his finances were so low, that he was obliged to dispose of his books, to enable him to execute that design.

He left England in June, 1655, and visited France, Italy, Turkey, &c. At several places, in the course of this tour, he met with kindness and liberal assistance from the English Ambassadors, &c. which enabled him to benefit the more, by protracting his stay and prolonging his journey. He spent more than a year in Turkey, and returned to England by way of Venice, Germany, and Holland, in 1659. At Constantinople he read over the works of St. Chrysostom, whom he preferred to all the other fathers.

On his return, Barrow was ordained by Bishop Brownrig; and in 1660, he was chosen to the Greek professorship at Cambridge. In July, 1662, he was elected professor of geometry in Gresham College: in this station, he not only discharged his own duty, but supplied likewise the absence of Dr. Pope, the astronomy professor. Among his lectures, some were upon the projection of the sphere and perspective, which are lost; but his Latin oration, introductory to his lectures, is still extant. About this time Mr. Barrow was offered a good living; but the condition annexed, of teaching the patron's son, made him refuse it, as thinking it too like a simoniacal contract. Upon the 20th of May, 1663, he was elected a fellow of the Royal Society, in the first choice made by the council after their charter. The same year the executors of Mr. Lucas having, according to his appointment, founded a mathematical lecture at Cambridge, they selected Mr. Barrow for the first professor; and though his two professorships were not incompatible with each other, he chose to resign that of Gresham College, which he did May the 20th, 1664. In 1669, he resigned the mathematical chair to his learned friend Mr. Isaac Newton, being now determined to quit the study of mathematics for that of divinity. On quitting his professorship, he had only his fellowship of Trinity College, till his uncle gave him a small sinecure in Wales, and Dr. Seth Ward, Bishop of Salisbury, conferred upon him a prebend in his church. In the year 1670 he was created doctor in divinity by mandate; and, upon the promotion of Dr. Pearson, master of Trinity College, to the See of Chester, he was appointed to succeed him by the king's patent, bearing date the 13th of February, 1672; upon which occasion the king was pleased to say, "he had given it to the best scholar in England." In this, his majesty did not speak from report, but from his own knowledge; the doctor being then his chaplain, he used often to converse with him, and, in his humorous way, to call him an "unfair preacher," because he exhausted every subject, and left no room for others to come after him. In 1675, he was chosen Vice-Chancellor of the University; and he omitted no endeavours for the good of that society, not in the line of his profession as a divine, for the promotion of piety and virtue; but his useful labours were abruptly terminated by a fever on the 4th of May, 1677, in the 47th year of his age. He was interred in Westminster Abbey, where a monument, adorned with his bust, was soon after erected, by the contribution of his friends.

Dr. Barrow's works are very numerous, and indeed various, mathematical, theological, poetical, &c. and such as do honour to the English nation. They are principally as follow:

1. Euclidis Elementa. Cantab. 1655, in 8vo.
2. Euclidis data. Cantab. 1657, in 8vo.
3. Lectiones Opticæ xviii. Lond. 1669, 4to.
4. Lectiones Geometricæ xiii. Lond. 1670, 4to.
5. Archimedis Opera, Apollonii Conicorum, libri iv. Theodosii Sphericorum, lib. iii; novo methodo illustrata, et succincte demonstrata. Lond. 1675, in 4to.

Barrow, in the salt-works, wicker cases, almost in the shape of a sugar-loaf, wherein the salt is put to drain.

Barrow, also denotes a large hillock, or mount of earth or stones, raised by the ancients, as a sepulchral monument, more especially over their illustrious dead. These barrows were, by the Romans, called *tumuli*, and are still to be seen in great numbers in almost all parts of Britain, Ireland, and the British Isles, as well as in several other countries. Some of these barrows appear rude and without order: others are more regular, and trenched round: some are the sepulchral monuments of ancient Britons: others of

Romans: and others of Saxons and Danes. In some have been found urns, ashes, and calcined bones: in others human skeletons.

Barrows are very numerous in Ireland: they are supposed to be of Scythian origin, and to have been introduced after the Romans had left it. It was a decree of Odin, the great Gothic legislator, that large barrows should be raised to perpetuate the memory of celebrated chiefs; these were composed of stone and earth, and were formed with great labour and art. At New Grange, in the county of Meath, is a mound of this kind, the altitude of which, from the horizontal floor of the cave, is about seventy feet, the circumference at the top is 300 feet, and the base covers two acres of land. It is founded on an amazing collection of stones, and covered with gravel and earth. Tumuli, or barrows, are also found in great numbers in America; and the American Indians are said to practise a similar mode of burial at this time, generally depositing with the body the implements of war and agriculture used by the deceased.

BARRULET, in heraldry, the fourth part of the bar, or the one half of the closset: an usual bearing in coat-armour.

BARRULY, in heraldry, is when the field is divided bar-ways, that is, across from side to side, into several parts.

BARRY, in heraldry, is when the escutcheon is divided bar-ways, that is, across from side to side, into an even number of partitions, consisting of two or more tinctures, interchangeably disposed: it is to be expressed in the blazon by the word *barry*, and the number of pieces must be specified; but if the divisions be odd, the field must be first named, and the number of bars expressed.

Barry-*bendy* is when an escutcheon is divided evenly, bar and bend-ways, by lines drawn transverse and diagonal, interchangeably varying the tinctures of which it consists.

Barry-*pily* is when a coat is divided by several lines drawn obliquely from side to side, where they form acute angles.

BARS, in music, lines drawn perpendicularly through the staves, to divide the notes into equal temporary quantities. By the assistance of these lines, the composer figures the correspondence of the parts of his score. It is also by their assistance that the performer is enabled to keep his time, and that a whole band, however numerous, is regulated and held together.

BARTERING, in commerce, the exchanging of one commodity for another, or the trucking wares for wares, among merchants. Bartering was the original and natural way of commerce, there being no buying till money was invented, though, in exchanging, both parties are buyers and sellers. The only difficulty in this way of dealing lies in the due proportioning the commodities to be exchanged, so as that neither party sustain any loss. Although the invention of money has not altogether put an end to barter, yet it has entirely prevented it from appearing in its real form in the books of merchants, as each article is there stated in its money value, and each sale is supposed to be paid for in the circulating medium of the country, even in cases where no money whatever is made use of in the transaction.

The following example will sufficiently explain the method of proportioning the commodities. Two merchants, A and B, barter; A would exchange 5 *C.* 3*qr.* 14*lb.* of pepper, worth 3*l.* 10*s.* per *C.* with B, for cotton worth 10*d.* per pound; how much cotton must B give A for this pepper?

In order to solve this question, and all others of the same nature, we must first find, by proportion, the true value of that commodity whose quantity is given, which, in the present case, is pepper: and then find how much of the other commodity will amount to that sum, at the rate proposed.

First, to find the value of the pepper, say, As 1 *C.* is to 3*l.* 10*s.* so is 5 *C.* 3*qr.* 14*lb.* to 20*l.* 11*s.* 3*d.* the true value of the pepper.

Then it is easy to conceive, that A ought to have as much cotton at 10*d.* per pound as will amount to 20*l.* 11*s.* 3*d.* which will be found by the following proportion.

As 10*d.* is to 1*lb.* so is 20*l.* 11*s.* 3*d.* to 4*C.* 1*qr.* 17½*lb.*—And so much cotton must B give A, for his 5*C.* 3*qr.* 14*lb.* of pepper.

BARTONIA, in botany, a genus of plants of the class Icosandria, and order Monogynia, named in honour of Professor Benjamin Smith Barton, by Pursh and Nuttall. The generic character is, Cal. superus, 5-fidus. Cor. polypetala. Caps. cylindrica, 1-ocularis, apice, operculatim, 3-5-valvis. Recep. 3-5-parietalia, duplici serie seminefera. There are only two species, both of which are described by Pursh; Bartonia ornata, and Bartonia polypetala. The former flowers in August and September, growing all the way from the river Plate to the Andes, on broken hills and the clefts of rocks. The flower of this species expands only in the evening, suddenly opening, after remaining closed all day. The other species, B. polypetala, is a perennial, growing on gravelly hills, near the Grand Detour, and flowers in August.

BARTRAMIA, in botany, is a genus of the Decandria Monogynia class of plants, the calyx of which is a perianthium, cut into five parts: the corolla consists of five wedge-shaped petals; the fruit is globular, and the seeds are four in number, convex on one side, and angular on the other.

BARTSIA, in botany, so named from Dr. Bartsch, the intimate friend of Linnæus, a genus of the Didynamia Angiospermia class of plants, whose flower consists of one petal, having the upper lip longest; the seeds are numerous, small, angular, and inclosed in capsules. There are five species, one called B. gymnandria, grows within the arctic circle, on the north side of the Frozen Ocean in Kamtschatka, where there is no other vegetation. The American species are six in number, according to Pursh.

BARUTH, an Indian measure, containing seventeen gantans: it ought to weigh about three pounds and an half of English avoirdupois.

BARYTES was discovered by Scheele in 1774; and the first account of its properties published by him in his Dissertation on Manganese. This is a very heavy mineral, most frequently of a flesh colour, of a foliated texture and brittle, very common in Britian and most other countries, especially in copper mines. It was known by the name of ponderous spar, and was supposed to be a compound of sulphuric acid and lime. Gahn analyzed this mineral in 1775, and found that it is composed of sulphuric acid, and the new earth discovered by Scheele. Scheele published an account of the method of obtaining this earth from ponderous spar. The experiments of these chemists were confirmed by Bergman, who gave the earth the name of terra ponderosa. Morveau gave it the name of barote, and Kirwan of barytes; which last was approved by Bergman, and is now universally adopted. Barytes may be obtained in a state of purity, by the calcination of its carbonate or nitrate. It exhibits, when pure, the following properties: 1. Barytes, in a pure form, has a sharp caustic taste, changes vegetable blue colours to green, and serves as the intermedium between oil and water: in these respects it bears a strong resemblance to alkalies. 2. When exposed to the flame of the blow-pipe on charcoal, it melts, boils violently, and forms small globules, which sink into the charcoal. If perfectly free from water, however, it is infusible. 3. If a small quantity of water be added to recently prepared barytes, it is absorbed with great rapidity; prodigious heat is excited; and the water is completely solidified, a sort of hard cement being obtained. A little more water converts this mass into a light bulky powder; and when completely covered with water, the barytes is dissolved. Boiling water should be employed for this purpose, unless sufficient temperature has been produced by the sudden addition of the whole quantity necessary for solution. 4. When the solution, prepared with boiling water, is allowed to cool slowly, it shoots into regular crystals. These have the form of flattened hexagonal prisms, having two broad sides, with two intervening narrow ones; and terminated at each end by a quadrangular pyramid. 5. The crystals are so soluble as to be taken up when heated, merely by their own water of crystallization. When exposed to a stronger heat, they swell, foam, and leave a dry white powder, amounting to about 47 parts from 100 of the crystals. This again combines with water with great heat and violence. At 60° of Fahrenheit, an ounce-measure of water dissolves only 25 grains of the crystals, *i. e.* they require for solution 17½ times their weight of water. Exposed to the atmosphere, they effloresce, and become pulverulent. 6. When added to spirit of wine, and heated in a spoon over a lamp, they communicate a yellowish colour to its flame. 7. The specific gravity of this earth, according to Fourcroy, is 4, but Hassenfratz states it at only 2.374. The former account, however, is the more probable. All its combinations have considerable specific gravity; and hence its name is derived, *viz.* from the Greek word *βαρυς*, signifying heavy. 8. Barytes does not unite with any of the alkalies.

BASALT, in mineralogy, occurs massive, in blunt and rolled pieces, and sometimes vesicular: its common colour is greyish black, of various degrees of intensity; from this it passes into ash-grey; sometimes to brown, and even in some varieties to raven black. It is dull internally, and the fracture is commonly coarse-grained and uneven. It occurs almost always in distinct concretions, which are usually columnar, and from a few inches to several fathoms, and even to upwards of 100 feet, in length. They are sometimes straight, sometimes bent, and either parallel or diverging. In mountains these concretions are collected into larger groupes, of which many together form a hill or a mountain. Sometimes the columns are articulated, and the joints have convex and concave faces. The specific gravity is by Bergman put at 3.0: by Brisson at 2.86: and by Kirwan at 2.98. Before the blow-pipe it easily melts without addition into an opaque black glass. By analysis the constituent parts have been brought out differently by different chemists, but according to Klaproth they are as follow:

Silica	44.50
Alumina	16.75
Oxide of iron	20.00
Lime	9.50
Magnesia	2.25
Oxide of manganese	0.12
Soda	2.60
Water	2.00
	97.62

It is found in vast mountainous beds, in most parts of the world, and almost always accompanies coal. The island of Staffa, on the western coast of Scotland, is entirely composed of basaltic pillars: the Giants Causeway, on the coast of Antrim, in Ireland, is a huge pavement of straight pillars, running to an unknown distance in the sea: the promontory of Fairhead, a little further to the north, exhibits a continued range, about a mile long, of columns 250 feet in height, and from 10 to 20 in diameter, being the largest yet known.

Basalt is employed as a building stone and touch stone; as a flux for certain ores of iron; in glass manufactures; in making the common green glass. The vesicular varieties are employed for millstones. Owing to its great hardness, the ancients, who were acquainted with its indestructibility, executed several fine works in it; many of which are preserved in great perfection to this day. The origin and formation of basalt are much controverted. Bergman introduced the theory of its aqueous formation; and to this Jameson inclines, from observing that the strata which are in contact with basalt generally exhibit appearances incompatible with the action of fire. Since the time of Bergman, the two theories have nearly equally divided the mineralogical world. The Swedes, Germans, and Wernerians in Britain, maintain the aqueous theory: they have shewn basalt resting upon and alternating with strata of acknowledged aqueous origin; they have discovered shells and vegetable remains imbedded in its substance; they have found its cavities filled by silicious nodules containing water; they have melted basalt in their furnaces, and have found it to produce glass; they have moreover shewn that the lava of Vesuvius and Etna differs in many important particulars from basalt; and they have pointed out the prismatic structure in many substances, which are not supposed to have undergone the action of fire.

The French, the Italians, and Dr. Hutton and his disciples in this country, maintain the igneous origin of basalt; in defence of their system they have shewn the prismatic structure of some undoubted Italian lavas: they have shewn beds of coal charred by the contact of dykes of basalt, and the forcible disruption, incurvation, and induration of argillaceous strata, when pierced through by means of this substance. Sir James Hall has proved that basalt, after it has undergone the vitreous fusion, may be made to assume a perfect stony appearance: and Mr. Watt has demonstrated, by experiment, that basalt may, by the medium of fire, acquire those peculiarities of structure that cannot readily be explained by the aqueous theory.

BASE, in architecture, is used for any body which bears another, but particularly for the lower part of a column and pedestal. The base of a column is that part between the shaft and the pedestal, if there be any pedestal; or if there be none, between the shaft and the plinth, or zocle. The base is diffent in the different orders. See Architecture.

Base, in chemistry, a term used to denote the earth, the alkali, or the metal of which a salt is formed in union with oxygen. It admits, however, of a more general application. The name of gas is given to any aeriform fluid, which consists of some substance combined with caloric, and capable of existing in an aeriform state under the usual pressure and temperature of the atmosphere: thus oxygen gas consists of oxygen, which is the base, and caloric. The alkalies, earth, and metals, are called salifiable bases or radicals, and the acids salifying principles. The name of each salt is composed of that of the acid and the salifiable base: thus sulphate of potash consists of sulphuric acid and potash, which is the base.

Base, in fortification, the exterior side of the polygon, or that imaginary line which is drawn from the flanked angle of a bastion to the angle opposite to it.

BASE, in geometry, the lowest side of the perimeter of a figure. Thus, the base of a triangle may be said of any of its sides, but more properly of the lowest, or that which is parallel to the horizon. In rectangled triangles, the base is properly that side opposite to the right angle.

Base *of a conic section*, a right line in the hyperbola and parabola, arising from the common intersection of the secant plane and the base of the cone.

Base *of a solid figure*, the lowest side, or that on which it stands; and if the solid has two opposite parallel plane sides, and one of them is the base, then the other is called the base also.

Base, in gunnery, the least sort of ordnance, the diameter of whose bore is 1¼ inch, weight 200 pounds, length 4 feet, load 5 pounds, shot 1½ pound weight, and diameter 1⅛ inch.

Base, in law. Base estate, such as base tenants have in their hands. Base tenure, the holding by villanage, or other customary services, as distinguished from the higher tenures in capite, or by military service. Base fee, is to hold in fee at the will of the lord, as distinguished from soccage tenure Base court, any court not of record.

Base *line*, in perspective, the common section of a picture, and the geometrical plane.

Base, or Bass, in music. See Bass.

BASELLA, in botany, a genus of the Pentandria Trigynia class and order. Natural order Holoraceæ; Atriplices, Juss. Essential character: calyx none; corolla seven-cleft; two opposite divisions shorter, at length buried: seed one. There are four species; the first, B. rubra, has thick, strong, succulent stalks, and leaves of a deep purple colour. This plant requires to be supported, for it will climb to the height of eight or ten feet. The flowers have no great beauty: but the plant is preserved for the odd appearance of the stalks and leaves. It is a native of the East Indies, Amboyna, and Japan. From the berries a beautiful colour is drawn: when used for painting, does not continue very long, but changes to a pale colour; and has also been used for staining calicoes in India.

BASEMENT, in architecture, a base continued a considerable length, as round a house, room, &c.

BSSILIC, in ancient architecture, a term used for a large hall, or public place, with aisles, porticoes, galleries, tribunals, &c. where princes sat, and administered justice in person. But the name has since been transferred, and is now applied to such churches, temples, &c. which, by their grandeur, as far surpass other churches, as princes' palaces do private houses: as also to certain spacious halls in princes' courts, where the people hold their assemblies: and to such stately buildings as the Palais at Paris, and the Royal Exchange at London, where merchants meet and converse.

BASILICON. See Pharmacy.

BASILICUS, in astronomy, *Cor Leonis*, a fixed star of the first magnitude in the constellation Leo. See Leo.

BASKET, a kind of vessel made of twigs interwoven together, in order to hold fruit, earth, &c.

The best baskets are made of osiers which thrive in moist places. To form an osier bed, the land should be divided into plots, eight or ten feet broad, by narrow ditches, and if there is a power of keeping water in these places, by means of a sluice, it is of the greatest importance in dry seasons. The common osier is cut at three years, but that with yellow bark not till the fourth. When the osiers are cut down, those that are intended for white work, such as baskets used in washing, are to be stripped of their bark while green. This is done by means of a sharp instrument, fixed into a firm block, over which the osiers are passed, and stripped of their covering with great velocity. They are then dried, and put in bundles for sale. Before they are worked, they must be soaked in water, which renders them flexible. The basket-maker usually sits on the ground to his business. Hampers, and other coarse work, are made of osiers without any previous preparation. The ancient Britons were celebrated for their ingenuity in making baskets, which they exported in great numbers. They were often of very elegant workmanship, and bore a high price.

Baskets *of earth*, in the military art, are small baskets used in sieges, on the parapet of a trench, being filled with earth. They are a foot and a half high, about a foot and a half diameter at the top, and eight or ten inches at bottom; so that, being set together, there is a sort of embrasures left at their bottoms, through which the soldiers fire, without exposing themselves.

Basket *fish*, a kind of star-fish caught in the seas of North America.

Basket *salt*, that made from salt

springs, being purer, whiter, and composed of finer grains than the common brine salt.

BASS, in music, that part of a concert which is most heard, which consists of the gravest and deepest sounds, and which is played on the largest pipes or strings of a common instrument, as of an organ, lute, &c. or on instruments larger than ordinary, for that purpose, as bass-viols, bassoons, bass-hautboys, &c. The bass is the principal part of a musical composition, and the foundation of harmony; for which reason it is a maxim among musicians, that when the base is good, the harmony is seldom bad.

Bass, *counter*, is a second or double bass, where there are several in the same concert.

Bass, *figured*, is that which, while a certain chord or harmony is continued by the parts above, moves in notes of the same harmony. Thus, if the upper parts consist of C, E, G, (the harmony of C,) and while they are continued, the bass moves from C, the fundamental note of that harmony, to E, another note of the same harmony; that bass is called a figured bass.

Bass, *fundamental*, is that which forms the tone or natural foundation of the incumbent harmony; and from which, as a lawful source, that harmony is derived: that is, if the harmony consist of the common chord of C, C will be its fundamental bass, because from that note the harmony is deduced; and if, while that harmony is continued, the bass be changed to any other note, it ceases to be fundamental, because it is no longer the note from which that harmony results and is calculated.

Bass *ground*, is that which starts with some subject of its own, and continues to be repeated throughout the movement, while the upper part or parts pursue a separate air, and supply the harmony. This kind of bass is productive of a monotonous melody, and has long since been rejected as a restraint upon the imagination.

Bass *thorough*, is the art by which harmony is superadded to any proposed bass, and includes the fundamental rules of composition. It is theoretical and practical: the former comprehends the knowledge of the connection and disposition of the several chords, the latter is conversant with the manner of taking the several chords on an instrument.

BASSANTIN (James), a Scotch astronomer, of the 16th century, born in the reign of James IV. of Scotland. He was a son of the laird of Bassantin, in the Merse. After finishing his education at the University of Glasgow, he travelled through Germany and Italy, and then settled in the University of Paris, where he taught mathematics with great applause. Having acquired some property in this employment, he returned to Scotland in 1562, where he died six years after.

From his writings it appears he was no inconsiderable astronomer, for the age he lived in; but, according to the fashion of the times, he was not a little addicted to judicial astrology. It was doubtless to our author that Sir James Melvil alludes in his Memoirs, when he says, that his brother Sir Robert, when he was using his endeavours to reconcile the two queens, Elizabeth and Mary, met with one Bassantin, a man learned in the high sciences, who told him, "that all his travail would be in vain; for," said he, "they will never meet together; and next, there will never be any thing but dissembling and secret hatred for a while, and at length captivity and utter wreck to our queen from England." He added, that "the kingdom of England at length shall fall, of right, to the crown of Scotland: but it shall cost many bloody battles; and the Spaniards shall be helpers, and take a part to themselves for their labour." A prediction in which Bassantin partly guessed right, which it is likely he was enabled to do, from a judicious consideration of probable circumstances and appearances.

Bassantin's works are, on astronomy, music, and various parts of the mathematics.

BASSET, a game at cards, said to have been invented by a noble Venetian, for which he was banished. The persons concerned in it are, a dealer, or banker, his assistant, who supervises the losing cards, and the punter, or any one who plays against the banker.

BASSIA, in botany, so called in honour of Ferdinando Bassi; a genus of the Dodecandria Monogynia class and order. Natural order of Dumosæ; Sapotæ, Jussieu. Essential character. Calyx four-leaved; corolla eight-cleft; tube inflated; stamina 16; drupe five-seeded. There are 3 species, of which B. longifolia is a lofty tree, with the outmost branches recurved, thickish, and covered with a grey down; berry fleshy, milky, with five seeds, one in each cell; they are oblong, slightly compressed, sometimes acuminate at each end, sometimes only at the base, very smooth, shining, yellow, with a white band; native of Malabar and Ceylon.

BASSOON, a musical instrument of the wind sort, blown with a reed, furnished with eleven holes, and used as a bass in a concert of hautboys, flutes, &c. To render this instrument more portable, it is divided into two parts, whence it is also called fagot. Its diameter at bottom is nine inches, and its holes are stopped like those of a large flute. The compass of the bassoon comprehends three octaves, extending from double B flat, to B above the treble-cliff note. The scale includes every semitone between its extremes, and its tone is so assimilated to that of the hautboy, as to render it the most proper bass to that instrument.

BASSO-RELIEVO, or BASS-RELIEF, a piece of sculpture, where the figures or images do not protuberate, jet, or stand out far above the plane on which they are formed. Whatever figures or representations are thus cut, stamped, or otherwise wrought, so that not the entire body, but only a part of it, is raised above the plane, are said to be done in relief, or relievo; and when that work is low, flat, and but a little raised, it is called low relief; when a piece of sculpture, a coin, or a medal, has its figure raised, so as to be well distinguished, it is called bold, and we say its relief is strong.

The origin of basso-relievo is said to have been described in the story of the maid of Corinth, related by Pliny, who says that the Sicyonian potter, her father, invented the following method of taking likenesses. His daughter being in love with a youth going to a foreign country, she circumscribed the shadow of his face with lines on the wall by lamp-light. Her father took the impression in clay and baked it among his vases.

BASSOVIA, in botany, a genus of the Pentandria Monogynia class and order. Essential character; corolla five-cleft; spreading, with a very short tube; berry ovate, knobbed, with many seeds. There is but one species; *viz.* B. sylvatica; the stems herbaceous, three or four feet high, branched; flowers in axillary corymbs, green and very small. Native of Guiana, in wet forests, flowering and fruiting in June.

BASS-VIOL, a musical instrument of a like form with that of a violin, but much larger. It is struck with a bow as that is, has the same number of strings, and has eight stops, which are subdivided into semi-stops; its sound is grave, and has a much nobler effect in a concert than that of the violin.

BASTARD, a natural child, or one born of an unmarried woman. By the laws of England, a bastard is incapable of inheriting land, as heir to his father; nor can any one inherit land as heir to him, except the children of his own body, born in wedlock; for by order of law, a bastard has no relation, of which it takes any notice, and he himself is accounted the first of his family. If a man marries a woman that is big with child by another, who was not her husband, and the child is born within the espousals, then it shall be deemed the child of the husband, and no bastard, though it were born but a day after the marriage; but this is understood when the parties are of age, and there is no apparent impossibility on the man's side. If a woman be with child by a man who afterwards marries her, and then the child is born, this child is no bastard; but if a man hath issue by a woman, before marriage, and afterwards marries her, the first issue is a bastard, by our laws, but legitimate by the civil law. If a woman elope from her husband, and he be within the four seas, her issue shall not be a bastard by our laws, though by the special law it shall: and if the wife continues in adultery, and has issue, it is a bastard in our law. If the husband and wife consent to live separate, and have issue afterwards, it shall be accounted legitimate, because the access of the husband shall be presumed; but if the contrary be found, it shall be a bastard.

BASTION, in the modern fortification, a huge mass of earth, faced usually with sods, sometimes with brick, and rarely with stone, standing out from a rampart, whereof it is a principal part, and is what, in the ancient fortification, was called a bulwark. A bastion consists of two faces and two flanks; the faces include the angle of the bastion; and their union makes the outmost, or the saliant angle, called also the angle of the bastion; and the union of the two faces to the two flanks makes the side-angles, called also the shoulders, or epaules; and the union of the two other ends of the flanks to the two curtains makes the angles of the flanks. See FORTIFICATION.

BASTON, in law, one of the servants to the warden of the Fleet-prison, who attends the king's courts with a red staff, for taking into custody such as are committed by the court. He also attends on such prisoners as are permitted to go at large by licence.

BASTON, or BATOON, in heraldry, a kind of bend, having only one third of the usual breadth. The baston does not go from side to side, as the bend or scarf does, being in the form of a truncheon. Its use is a note or mark of bastardy.

BASTONADE, or **Bastinado**, a kind of punishment inflicted by beating the offender with a stick. This sort of beating, among the ancient Greeks and Romans, was the punishment commonly inflicted on criminals that were freemen, as that of whipping was on the slaves. We find some instances of this sort of discipline among the Hebrews; and it is a penalty used in the east at this day.

BAT. See **Vespertilio**.

Bat, *fowling*, a method of catching birds in the night, by lighting some straw, or torches, near the place where they are at roost; for upon beating them up, they fly to the flame, where, being amazed, they are easily caught in nets, or beat down with bushes fixed to the end of poles, &c.

BATH, *knights of the*, a military order in England, supposed to have been instituted by Richard II. who limited the number of knights to four; however, his successor, Henry IV. increased them to forty-six. Their motto is "Tria juncta in uno," signifying the three theological virtues.

This order received its denomination from a custom of bathing before the knights received the golden spur. They wear a red ribband beltwise, appendant to which is the badge or symbol of the order, which is a sceptre, rose, thistle, and three imperial crowns, conjoined within a circle, upon which circle is the motto, and all of pure gold. Each knight wears a silver star of eight points upon the left breast of his upper garment.

The order of the bath, after remaining many years extinct, was revived under George the First, by a solemn creation of a great number of knights.

Bath-*col*, the daughter of a voice. So the Jews call one of their oracles, which is frequently mentioned in their books, especially the Talmud, being a fantastical way of divination, invented by the Jews themselves, not unlike the sortes virgilianæ of the heathens. However, the Jewish writers call this a revelation from God's will, which he made to his chosen people, after all verbal prophecies had ceased in Israel.

BATIS, in botany, a genus of the Dioecia Tetrandria class and order. Essential character: male ament four-fold, imbricate; calyx and corolla none. Female ament ovate; involucre two-leaved; calyx and corolla none; stigma two-lobed, sessile: berries conjoined, four-seeded. There is but one species, viz. B. maritima, a shrub four feet high, with a round ash-coloured stem, much branched; stigmas white; fruits yellow or greenish yellow. The plant is salt to the taste, and is burnt for barilla at Carthagena. Native of the Caribbee islands and the neighbouring continent.

BATMAN, in commerce, a kind of weight used at Symrna, containing six okes, of four hundred drachms each, which amount to 16 pounds, 6 ounces, and 15 drachms of English weight.

BATTALION, a small body of infantry, ranged in form of battle, and ready to engage.

A battalion usually contains from 5 to 800 men; but the number it consists of is not determined. They are armed with fire-locks (pikes being quite laid aside) swords and bayonets; and divided into thirteen companies, one of which is grenadiers. They are usually drawn up with three men in file, or one before another. Some regiments consist but of one battalion, others are divided into four or five.

BATTEL, a trial by combat, which was anciently allowed by our laws, where the defendant, in an appeal of murder or felony, might fight with the appellant, and make proof thereby, whether he were culpable or innocent. This mode of trial was used also in one civil case, namely, upon an issue joined in a writ of right; but as the writ of right itself is now disused, this course of trial is only matter of speculation.

BATTEN, a name that workmen give to a scantling of wooden stuff, from two to four inches broad, and about one inch thick; the length is pretty considerable, but undetermined.

BATTERING, the attacking a place, work, or the like, with heavy artillery. To batter in breach, is to play furiously on a work, as the angle of a half moon, in order to demolish and make a gap therein. In this they observe never to fire a piece at the top, but all at the bottom, from three to six feet from the ground. The battery of a camp is usually surrounded with a trench and pallisadoes at the bottom, with two redoubts on the wings, or certain places of arms, capable of covering the troops which are appointed for their defence.

BATTERY, in the military art, a parapet thrown up to cover the gunners and men employed about the guns from the enemy's shot. This parapet is cut into embrasures for the cannon to fire through. The height of the embrasures, on the inside, is about three feet; but they go sloping lower to the outside. Their wideness is two or three feet, but open to six or seven on the outside. The mass of earth that is betwixt two embrazures is called the merlon. The platform of a battery is a floor of planks and sleepers, to keep the wheels of the guns from sinking into the earth; and is always made sloping towards the embrazure, both to hinder the reverse, and to facilitate the bringing back of the gun.

Battery, in law, the striking, beating, or offering any violence to another person, for which damages may be recovered. But if the plaintiff made the first assault, the defendant shall be quit, and the plaintiff amerced to the king for his false suit. Battery is frequently confounded with assault, though in law they are different offences; for in the trespass for assault and battery, one may be found guilty of assault, yet acquitted of the battery; there may, therefore, be assault without battery, but battery always implies an assault.

Battery. See Electricity and Galvanism.

BATTLE, a general engagement between two armies, in a country sufficiently open for them to encounter in front, and at the same time; or, at least, for the greater part of the line to engage. Other great actions, though of a longer duration, and even attended with a greater slaughter, are only called fights.

The loss of a battle frequently draws with it that of the artillery and baggage; the consequence of which is, that, as the army beaten cannot again look the enemy in the face till these losses have been repaired, it is forced to leave the enemy a long time master of the country, and at liberty to execute all their schemes; whereas a great fight lost is rarely attended with the loss of all the artillery, and scarcely ever of the baggage. See Tactics.

Battle, *naval*, the same with a sea-fight, or engagement between two fleets of men of war. Before a naval battle, every squadron usually subdivides itself into three equal divisions, with a reserve of certain ships out of every squadron to bring up their rear. Every one of these, observing a due birth and distance, are in the battle to second one another; and the better to avoid confusion and falling foul of each other, to charge, discharge, and fall off by threes or fives, more or less, as the fleet is greater or smaller. The ships of reserve are instructed either to succour and relieve those that are any way in danger, or to supply and put themselves in the place of those that shall be made unserviceable. See Tactics.

BAUERA, in botany, a genus of the Polyandria Monogynia class and order. Calyx eight-leafed; petals eight; capsule two-celled, two-valved, many-seeded. One species, which is a native of New Holland.

BAUHINIA, in botany, so called in honour of the two famous botanists, John and Caspar Bauhin, a genus of the Decandria Monogynia class and order. Natural order of Lomentaceæ; Leguminosæ, Jussieu. Essential character: calyx five-cleft, deciduous; petals expanding, oblong, with claws, the upper one more distant, all inserted into the calyx, legume. There are 13 species, of which B. aculeata is an erect shrub, the height of a man; the trunk and branches are very prickly: leaves roundish; the two lobes also are roundish and blunt; the flowers are large, white, and have a scent which is somewhat unpleasant; sometimes the fold of the calyx is entire, not cloven. Mr. Miller says that it rises to the height of sixteen or eighteen feet in Jamaica, where it grows plentifully, and the other sugar islands in America; that the stalks are terminated by several long spikes of yellow flowers, which are succeeded by bordered pods about three inches long, containing two or three swelling seeds; that these pods are glutinous, and have a strong balsamic scent, as have also the leaves when bruised; and that it is called in America the Indian savin tree, from its strong odour, somewhat resembling the common savin.

BAWDY-*house*, a house of ill fame, to which lewd persons of both sexes resort, and there have criminal conversation.

The keeping a bawdy-house is a common nuisance, not only on account that it endangers the public peace by drawing together debauched and idle persons, and promoting quarrels, but likewise for its tendency to corrupt the manners of the people. And, therefore, persons convicted of keeping bawdy-houses are punishable by fine and imprisonment; and to such other punishment as the court, at their discretion, shall inflict.

BAXTERIANS, in church history, a sect of Christians, who look up to the celebrated Richard Baxter as their founder, and who make the tenets of that worthy man the foundation of their faith. The object of Baxter was a hopeless cause: it was to reconcile the opinions of Calvin and Arminius, and his scheme is called the middle scheme. Although the old adage, that the middle path is the safest, may be true in many things relating to the conduct of life, yet where truth and religion are concerned, there can be no middle way. There is no medium between what is true and what is erroneous. Baxter taught, that God elected some whom he determined to save, without any foresight of their good works, and that others, to whom the gospel is preached, have the means of salvation put into their hands. He contended that the merits of Christ's death, of which he appears to have had no precise idea, are to be applied to believers only, but all men are in a state capable of salvation. Mr Baxter also assumed, that there may be a certainty of perseverance here; and yet he cannot tell whether a man may not have so weak a degree of saving grace as to lose it again.

BAYER, (JOHN) in biography, a German lawyer and astronomer of the latter part of the 16th and beginning of the 17th century, but in what particular year or place he was born is not certainly known: however, his name will be ever memorable in the annals of astronomy, on account of that great and excellent work which he first published in the year 1603, under the title of "Uranometria," being a complete celestial atlas, or large folio charts of all the constellations, with a nomenclature collected from all the tables of astronomy, ancient and modern, with the useful invention of denoting the stars in every constellation by the letters of the Greek alphabet, in their order, and according to the order of magnitude of the stars in each constellation. By means of these marks the stars of the heavens may, with as great facility, be distinguished and referred to, as the several places of the earth are by means of geographical tables; and as a proof of the usefulness of this method, our celestial globes and atlasses have ever since retained it; and hence it is become of general use through all the literary world; astronomers, in speaking of any star in the constellation, denoting it by saying it is marked by Bayer, α, or β, or γ, &c.

Bayer lived many years after the first publication of this work, which he greatly improved and augmented by his constant attention to the study of the stars. At length, in the year 1627, it was republished under a new title, *viz.* "Cœlum Stellatum Christianum, that is, the Christian Stellated Heaven, or the Starry Heavens Christianized;" for in this work, the Heathen names and characters, or figures of the constellations, were rejected and others, taken from the scriptures, were inserted in their stead, to circumscribe the respective constellations. But this was considered too great an innovation, and we find in the later editions of the work that the ancient figures and names were restored.

BAYONET, in the military art, a short broad dagger, formerly with a round handle, fitted for the bore of a firelock, to be fixed there after the soldier had fired; but they are now made with iron handles and rings, that go over the muzzle of the firelock, and are screwed fast, so that the soldier fires with his bayonet on the muzzle of his piece, and is ready to act against horse.

BAYS, in commerce, a sort of open woollen stuff, having a long knap, sometimes frized, and sometimes not. This stuff is without wale, and is wrought in a loom with two treddles, like flannel. It is chiefly manufactured at Colchester and Bocking in Essex, where there is a hall called the Dutch bay hall, or raw hall.

BEACON, a public signal, to give warning against rocks, shelves, invasions, &c.

The corporation of the Trinity-house are empowered to set up beacons wherever they shall think necessary, and if any destroy or take them down, he shall forfeit 100*l.* or be *ipso facto* out-lawed. There are other beacons put up to give warning of the approach of an enemy; these are made by putting pitch barrels upon a long pole, to be set upon an eminence, so as they may be seen afar off; for the barrels being fired, the flame in the night time, and the smoke in the day, give notice, and in a few hours may alarm the whole kingdom, upon an approaching invasion, &c.

BEADS, in the arts, are small globules, chiefly used for necklaces, and are made of pearl, steel, garnet, coral, diamond, amber, crystal, paste, glass, &c. There is a large trade, chiefly of coral, amber, and glass beads, carried on with the uninformed inhabitants of the coast of Africa and the East India islands. Roman Catholics make use of beads in rehearsing their prayers, and they are applied to the same use among the dervices and other religious sects in the East.

BEAD, in architecture, a round moulding, commonly made upon the edge of a piece of stuff, in the Corinthian and Roman orders, cut or carved in short embossments, like beads in necklaces.

Sometimes a plain bead is set on the edge of each fascia of an architrave, and sometimes, likewise, an astragal is thus cut. A bead is often placed on the lining board of a door-case, and on the upper edges of skirting-boards.

BEAK, or **Beak**-*head*, of a ship, that part without the ship, before the forecastle, which is fastened to the stem, and is supported by the main knee. This name is appropriated to ships whose forecastle is square or oblong, a circumstance common to all vessels which have two or more tiers of guns. In smaller ships the forecastle is generally shaped like a parabola, the vertex of which lies immediately above the stem. The strong projecting pointed beaks, used by the ancients in time of battle, are entirely disused since the invention of gunpowder.

BEAKED, in heraldry, a term used to express the beak and bill of a bird. When the beak and legs of a fowl are of a different tincture from the body, we say beaked and membered of such a tincture.

BEAM, in architecture, the largest piece of wood in a building, which lies across the walls, and serves to support the principal rafters of the roof, and into which the feet of these rafters are framed. No building has less than two of these beams, *viz.* one at each end. Into these the girders of the garret roof are also framed; and if the building be of timber, the teazle tenons of the posts are framed into them. The proportion of beams in or near London are fixed by statute.

Beam *compass*, an instrument consisting of a square wooden or brass beam, having sliding sockets that carry steel or pencil points: they are used for describing large circles, where the common compasses are useless.

Beams *of a ship*, are the great main cross-timbers which hold the sides of the ship from falling together, and which also support the decks and orlops: the main beam is next the main mast, and from it they are reckoned, by first, second, third beam, &c.: the greatest beam of all is called the mid-ship beam.

Beam, or *Roller*, among weavers, a long and thick wooden cylinder, placed lengthways on the back part of the loom of those who work with a shuttle.

That cylinder, on which the stuff is rolled as it is weaved, is also called the beam, or roller, and is placed on the fore part of the loom.

BEAN. See Vicia.

BEAR. See Ursus.

Bear, in astronomy. See Ursa.

Bear, in heraldry. He that has a coat of arms, is said to bear in it the several charges or ordinaries that are in his escutcheon.

Bear, in gunnery. A piece of ordnance is said to come to bear, when it lies right with, or directly against, the mark.

BEAR'S *Breech*, in botany. See Acanthus.

BEARD, the hair growing on the chin, and adjacent parts of the face, chiefly of adults and males.

Various have been the ceremonies and customs of most nations in regard of the beard. The Tartars, out of a religious principle, waged a long and bloody war with the Persians, declaring them infidels, merely because they would not cut their whiskers, after the rite of Tartary: and we find, that a considerable branch of the religion of the ancients consisted in the management of their beards.

Ecclesiastics have sometimes been enjoined to wear, and at other times have been forbid the wearing the beard; and the Greek and Romish churches have been a long time by the ears about their beards. To let the beard grow, in some countries, is a token of mourning, as to shave it is the like in others.

The Greeks wore their beards till the time of Alexander the Great, that prince having ordered the Macedonians to be shaved, for fear it should give a handle to their enemies: the Romans did not begin to shave till the year of Rome 454. Nor did the Russians cut their beards till within these few years, that Peter the Great, notwithstanding his injunctions upon them to shave, was obliged to keep on foot a number of officers, to cut off, by violence, the beards of such as would not otherwise part with them.

Beard *of a comet*, the rays which the comet emits towards that part of the heaven to which its proper motion seems to direct it: in this the beard of a comet is distinguished from the tail, which is understood of the rays emitted towards that part from whence its motion seems to carry it.

BEARER *of a bill of exchange*, the person in whose hands the bill is, and in favour of whom the last order was made.

When a bill is made payable to the bearer, it is understood to be payable to him in whose hands it is after it becomes due.

Bearers, in heraldry. See **Supporters**.

BEARING, in navigation and geography, the situation of one place from another, with regard to the points of the compass; or the angle which a line drawn through the two places makes with the meridians of each.

The bearings of places on the ground are usually determined from the magnetic needle, in the managing of which consists the principal part of surveying, since the bearing or distance of a second point from a first being found, the place of that second is determined; or the bearings of a third point from two others, whose distance is known, being found, the place of the third is determined instrumentally. But to calculate trigonometrically, there must be more data.

Bearing, in the sea language. When a ship sails towards the shore, before the wind, she is said to bear in with the land or harbour. To let the ship sail more before the wind, is to bear up. To put her right before the wind, is to bear round. A ship that keeps off from the land, is said to bear off. When a ship that was to windward comes under another ship's stern, and so gives her the wind, she is said to bear under her lee, &c. There is another sense of this word, in reference to the burden of a ship; for they say a ship bears, when, having too slender or lean a quarter, she will sink too deep into the water with an over light freight, and thereby can carry but a small quantity of goods.

Bearing *of a piece of timber*, among carpenters, the space either between the two fixed extremities thereof, when it has no other support, which they call bearing at length, or between one extreme and a post, brick wall, &c. trimmed up between the ends, to shorten its bearings.

BEAT, in music, a transient grace note, struck immediately before the note it is intended to ornament. The beat always lies half a note beneath its principal, and should be heard so closely upon it, that they may almost seem to be struck together.

Beat *of drum*, in the military art, to give notice by beat of drum of a sudden danger; or that scattered soldiers may repair to their arms and quarters, is to beat an alarm, or to arms; also to signify, by different manners of sounding a drum, that the soldiers are to fall on the enemy; to retreat before, in, or after an attack; to move, or march, from one place to another; to treat upon terms, or confer with the enemy; to permit the soldiers to come out of their quarters at break of day, in order to repair to their colours, &c. is to beat a charge, a retreat, a march, &c.

BEATING *gold and silver*. See **Gold Beating**.

Beating *time*, in music, a method of measuring and marking the time for performers in concert, by the motion of the hand and foot up and down successively, and in equal times. Knowing the true time of a crotchet, and supposing the measure actually subdivided into four crotchets, and the half measure into two, the hand or foot being up, if we put it down with the very beginning of the first note or crotchet, and then raise it with the third, and then down with the beginning of the next measure, this is called beating the time; and by practice, a habit is acquired of making this motion very equal. Each down and up is sometimes called a time, or measure.

The general rule is, to contrive the division of the measure so, that every down and up of the beating shall end with a particular note, on which very much depends the distinctness, and, as it were, the sense of the melody. Hence, the beginning of every time or beating in the measure is reckoned the accented part thereof.

If time be common, or equal, the beating is also equal; two down and two up, or one down and one up: if the time be triple, or unequal, the beating is also unequal; two down and one up.

BEATINGS, in music, those regular pulsative heavings or swellings of sound, produced in an organ by pipes of the same key when they are not exactly in unison, *i. e.* when their vibrations are not perfectly equal in velocity; not simultaneous and coincident.

BEATS, in music, are certain pulsations of two continued sounds, as in an organ, that are out of tune, occasioned by warring vibrations that prevent coincidence in any two concords. This phenomenon Dr. Smith has made the foundation of a system of temperament. In tuning musical instruments, especially organs, it is a known thing, that while a consonance is imperfect, it is not smooth and uniform as when perfect, but interrupted with very sensible undulations or beats, which, while the two sounds continue at the same pitch, succeed one another in equal times, and in longer and longer times, while either of the sounds approaches gradually to a perfect consonance with the other, till at last the undulations vanish, and have a smooth and uniform consonance. These beats are of use in tuning an organ to any degree of exactness. The beats of two dissonant organ pipes resemble the beating of the pulse to the touch: and, like the human pulse in a fever, the more dissonant are the sounds, the quicker they beat, and the slower as they become better in tune, till at length they are lost in the coincident vibrations of the two sounds.

Beats, in a watch or clock, are the strokes made by the fangs or pallets of the spindle of the balance, or of the pads in a royal pendulum. To find the beats of the balance in all watches going, or in one turn of any wheel. Having found the number of turns which the crown-wheel makes in one turn of the wheel you seek for, those turns of the crown-wheel, multiplied by its notches, give half the number of beats in that one turn of the wheel. For the balance or swing has two strokes to every tooth of the crown-wheel, inasmuch as each of the two pallets hath its blow against each tooth of the crown-wheel; whence it is, that a pendulum that beats seconds has in its crown-wheel only 30 teeth. See Watch-work.

BEAVER, in zoology. See Castor.

BEAUTY, a general term for whatever excites in us pleasing sensations, or an idea of approbation.

Hence the notion annexed to beauty may be distinguished into ideas and sensations; the former of which occupy the mind; the latter affect the heart: thus, an object may please the understanding without interesting the sense; and on the other hand, we perceive agreeable sensations, excited by some objects, whose ideas are no way related to any thing that is praise-worthy.

It is on account of these distinctions, that the difficulty lies of fixing an universal characteristic of beauty, in regard that the persons vary, according to their different turns of mind, and habitudes of body; and consequently the relations of objects to those ideas and sensations do in like manner vary; whence arise the different opinions of beauty in painting, women, &c.

Beauty, in its most extensive sense, may perhaps be properly defined, that quality or union of qualities in the objects of perception, whether they be material, intellectual, or moral, which is best calculated to excite emotions of pleasure in the minds of intelligent creatures. We say calculated to produce these effects in the minds of intelligent creatures, because, although beauty is, like truth, unchangeable in itself, it is only in proportion to the measure of our intelligence that we are capable of perceiving and enjoying it. Hence the distinction between beauty and taste; the former, the object, ever existing, ever the same; the latter, the power of perception, fluctuating and changing, in proportion to the perfection of our organs of sense and the improvement of our reasoning faculties. That the organs of sense vary in their degrees of perfection in different men, experience every day demonstrates: that the eye of one, the ear of another, the palate, the smell, or the touch of a third, is by nature formed with more exquisite workmanship than in others, no one can doubt; and that these organs of sense can be again rendered still more correct by their particular education or frequent practice, is equally certain. Thus the man, whose eye has been long accustomed to measure distances, shall seldom be under the necessity of recurring to the rule; the accomplished artist shall in a moment discover the various colours, and the proportions of each required to produce any complex tint, or, like Apelles, draw the line marking the scarcely perceptible distinction between excellence and perfection.

Beauty as opposed to deformity, is as goodness to evil, as truth to falsehood, or as right to wrong, and may therefore be considered as an outward demonstration vouchsafed by the Almighty, to bring us, by analogy, to the contemplation of those divine attributes by which we are bound to regulate our lives in this material world, that we may be fitted for that state of purity and happiness which we are promised in the world of spiritual existence. If this conclusion be admitted, it is no longer a question why beauty gives us pleasure; it is sufficient that it does so.

But if mankind are not by nature equally endowed with the powers of discriminating or judging of beauty, what is the standard or rule by which we are to ascertain what is really beautiful, much less the different degrees of beauty which any given object presents? for will not each man say, my judgment is right; your's, inasmuch as you differ from me, wrong?

To this, and similar objections, we should not hesitate to reply thus: Although no individual can properly be considered a competent and unerring judge, mankind, in the aggregate, may: and we can therefore safely rest satisfied, that what the wisest, the most virtuous, and the most contemplative men, of all ages, have agreed to sanction by their approval, is right. Taste may be, for a time, perverted by fashion, meretricious charms may usurp the rank of beauty, ostentation may personate virtue; but truth and justice will at length prevail, whilst the frivolity or caprice of a day will be soon forgotten.

The surest method therefore, nay, perhaps, the only means by which we can expect to perfect our taste, so as to be enabled to relish the higher beauties which either the productions of nature or art present, is by an early and close application to the study and contemplation of those works, which have proved impervious to the shafts of criticism, and which have been the admiration of ages.

Such are the writings of the best ancient authors, whether in prose or verse, such the astonishing remains of Greek art, which, long hidden in the bowels of the earth, were restored to light under the happy auspices of Lorenzo de Medici and Leo the Tenth. Next to these, as authorities, we may class the best established works of modern date; and particularly those which appeared soon after the revival of letters and arts; mankind having had, in cases of this description, more leisure and opportunity to correct the errors and prejudices to which contemporary opinion is subjected, than can have been possible with respect to very recent productions.

Inquiries concerning beauty have employed the pens of many ingenious and learned authors of all ages; the subject, however, is, like nature, inexhaustible, and, like her, perhaps, beyond the reach of human talents fully to comprehend, or satisfactorily to explain. Dr. Hutchinson's theory of beauty ascribes it to "uniformity amidst variety," (see "Hutchinson's Inquiry") but another writer (see "Reid's Essay on the Intellectual Powers of Man," ch. iv.) observes, that beauty is found in things so various and so very different in nature, that it is difficult to say wherein it consists, or what can be common to all the objects in which it is found. Hogarth, in his "Analysis of Beauty," considers the elements of beauty to be, fitness, variety, uniformity, simplicity, intricacy, and quantity: whereas Mr. Burke in his "Inquiry respecting the Sublime and Beautiful," excludes, from the number of real causes of beauty, the proportion of parts, fitness, or that idea of utility, which consists in a part's being well adapted to anwer its ends; and also perfection.

Opinions so contradictory may well justify the hypothesis, that beauty is more readily felt than described; and we may set down contented, that we receive light and heat from the sun, although ignorant whether it proceeds from a burning orb or a huge stone.

As the attainment of beauty is a principal aim of the fine arts, the subject will necessarily again fall under discussion, as connected with each of them in particular. See ARTS, *Fine*, POETRY, PAINTING, DRAWING, SCULPTURE, ENGRAVING, DANCING.

BECHERA, in botany, a genus of the Pentandria Digynia class and order. Calyx five-cleft, superior, with a globular tube; coral five petalled; capsule two-celled, two-valved. One species.

BECKETS, in sea language, any thing used to confine loose ropes, tackles, or spars, in a convenient place: hence beckets are either large hooks, or short pieces of rope with a knot on one end, and an eye in the other; or formed like a circular wreath; or they are a sort of wooden brackets.

BEE. See APIS.

BEES, *management of.* It is agreed by the most judicious observers, that the apiary, or place were bees are kept, should face the south, and be situated in a place neither too hot nor too much exposed to the cold; that it be near the mansion-house, on account of the convenience of watching them; but so situated as not to be exposed to noisome smells, or to the din of men or cattle; that it be surrounded with a wall, which, however, should not rise above three feet high; that, if possible, a running stream be near them; or if that cannot be, that water be brought near them in troughs, as they cannot produce either combs, honey, or food for their maggots, without water; and that the garden in which the apiary stands be well furnished with such plants as afford the bees plenty of good pasture. Furze, broom, mustard, clover, heath, &c. have been found excellent for this purpose. Hives have been made of different materials, and in different forms, according to the fancy of people of different ages and countries. Not only straw, which experience now proves to be rather preferable to every thing else, but wood, horn, glass, &c. have been used for the construction of them. Single box hives, however, when properly made, answer very well, and when painted last long. They have several advantages above straw hives; they are quite cleanly, and always stand upright; they are proof against mice, and are cheaper in the end than straw hives, for one box will last as long as three of them. They are, however, rather colder in winter; but a proper covering will prevent all danger from that quarter. Straw hives are easiest obtained at first, and have been used and recommended by the best of bee-masters. If the swarm be early and large, it will require a large hive; but if otherwise, the hive should be proportionably less. If the bees appear to want more room, it can easily be enlarged by putting a roll or two below it; but if it be heavy enough for a stock hive, it will do, although it should not be quite full of combs. Any person (says Mr. Bonner) who intends to erect an apiary, must take particular care to have it filled with proper inhabitants. He must be peculiarly attentive to this, as all his future profit and pleasure, or loss and vexation, will, in general, depend upon it. He must, therefore, pay the utmost attention to the choice of his stock-hives; for the man who takes care to keep good stock-hives will gain considerably by them; but he who keeps bad ones will, besides a great deal of trouble and little or no success, soon become a broken bee-master. In September every stock-hive ought to contain as much honey as will supply the bees with food till June following, and as many bees as will preserve heat in the hive, and therefore resist the severity of a cold winter, and act as so many valiant soldiers, to defend the community from the invasions of foreign enemies in spring. They should be full of combs, and well stored with bees and honey, and should weigh at least 30*lb.* each; if heavier, so much the better; for light hives run a great risk of perishing by famine, unless the bees are supplied with food; whereas a well-chosen hive of 30*lb.* weight, allowing 12*lb.* for the empty hive, bees, comb, &c. will contain 18*lb.* of honey, which will supply the bees with food till June; a time when it may be presumed they will find abundance of provisions for themselves among the flowers. When a choice can be obtained, the youngest hive should always be preferred, because old hives are liable to vermin and other accidents. But although a hive should be four or five years old, it should not be rejected, if it possess these two essential qualities, plenty of bees and abundance of honey.

Bees first swarm in May or in the end of April; but earlier or later according to the warmth of the season. They seldom swarm before ten in the morning, and seldom later than three in the afternoon. We may know when they are about to swarm, by clusters of them hanging on the outside of the hive. But the most certain sign is when the bees refrain from going into the fields, though the season be inviting. Just before they take flight there is an uncommon silence in the hive: after this, as soon as one takes flight, they all follow. Before the subsequent swarmings there is a great noise in the hive, which is supposed to be occasioned by a contest whether the young or old queen should go out. When the bees of a swarm fly too high, they will descend lower upon throwing handfuls of sand or dust among them, which they probably mistake for rain. For the same purpose it is usual to beat on a kettle or frying-pan; this practice may have taken its rise from observing that thunder, or any great noise, prompts bees in the fields to return home. As soon as the swarm is settled, the bees which compose it should be got into a hive with all convenient speed, to prevent their taking wing again. If they settle on a small branch of a tree, easy to come at, it may be cut off and laid upon a cloth, the hive being ready immediately to put over them. If the branch cannot be conveniently cut, the bees may be swept from off it into the hive. Lodge but the queen into the hive, and the rest will soon follow. If the bees must be considerably disturbed in order to get them into a hive, the most advisable way is, to let them remain in the place where they have pitched till the evening, when there is less danger of their taking wing. If it be observed that they still hover about the tree that they first alighted upon, the branches may be rubbed with rue, elder leaves, or any other thing distasteful to them, to prevent their returning to it. The hive employed on this occasion should be cleaned with the utmost care, and its inside rubbed with fragrant herbs or flowers, the smell of which is agreeable to the bees, or with honey. The hive should not be immediately set on the stool where it is to remain, but kept near the place at which the bees settled till the evening, lest some stragglers should be lost. It should be shaded either with boughs or with cloth, that the too great heat of the sun may not annoy the bees. We sometimes see a swarm of bees, after having left their hive, and even alighted upon a tree, return to their first abode: this never happens but when the young queen did not come forth with them, for want of strength, or perhaps courage to trust to her wings for the first time, or possibly from a consciousness of her not being impregnated.

When a swarm is too few in number for a hive, another may be added. The usual method of thus uniting swarms is very easy; spread a cloth at night upon the ground, close to the hive in which the two casts or swarms are to be united, lay a stick across this cloth, then fetch the hive with the new swarm, set it over the stick, give a smart stroke on the top of the hive, and all the bees will drop down upon the cloth in a cluster; this done, throw aside the empty hive, take the other from off the stool, and set this last over the bees, who will soon ascend into it, mix with those already there, and become one and the same family. Others, instead of striking the bees down upon the cloth, place with its bottom upmost the hive in which the united swarms are to live, and strike the bees of the other hive down into it. The former of these hives is then restored to its natural situation, and the bees of both hives soon unite. If some bees still adhere to the other hive, they may be brushed off on the cloth, and they will soon join their brethren. Or we may take the following method, which gives less disturbance to the bees; set, with its mouth upmost, the hive into which the young swarm has been put, and set upon it the other hive. The bees in the other hive, finding themselves in an inverted situation, will soon ascend into the upper. A large swarm may weigh 8*lb.* and so gradually less to 1*lb.*: consequently, a very good one may weigh 5 or 6*lb.* All such as weigh less than 4*lb.* should be strengthened, by uniting to each of them a less numerous swarm.

Providence has ordained that insects which feed on leaves, flowers, and green succulent plants, are in an insensible or torpid state, from the time that the winter's cold has deprived them of the means of subsistence: thus the bees, during the winter, are in so lethargic a state, that little food supports them; but as the weather is very changeable, and every warm or sunny day revives them, and prompts them to return to exercise, food becomes necessary on these occasions.

Many hives of bees which are thought to die of cold in winter, in truth, die of famine, when a rainy summer has hindered the bees from laying in a sufficient store of provisions. The hives should therefore be carefully examined in autumn, and should then weigh at least 18 pounds. The common practice is, to feed them in autumn, giving them as much honey as will bring the whole weight of the hive to near 20 pounds. The easiest and most rational method is, to set under the hive a plate of liquid honey, with a paper pierced full of holes, through which the bees will suck the honey without daubing themselves. In case honey cannot be procured, a mixture of brown sugar, wetted with strong beer, will answer every purpose. Another circumstance, which may render it very necessary to feed the bees is, when several days of bad weather ensue immediately after they have swarmed; for then, being destitute of every supply beyond what they carried with them, they may be in great danger of starving. In this case, honey should be given them in proportion to the duration of the bad weather. In this country it is usual, in seizing the stores of these little animals, to rob them also of their lives. The common method is, that when those which are doomed for slaughter have been marked out, (which is generally done in September,) a hole is dug near the hive, and a stick, at the end of which is a rag that has been dipped in melted brimstone, being stuck in that hole, the rag is set on fire, the hive is immediately set over it, and the earth is instantly thrown up all around, so that none of the smoke can escape. In a quarter of an hour all the bees are seemingly dead, and they are rendered soon after irrecoverably so, by being buried in the earth that is returned back into the hole. By this last means it is that they are absolutely killed; for it has been found by experiment, that all the bees which have been affected only by the fume of the brimstone recover again, excepting such as have been singed or hurt by the flame. Hence it is evident, that the fume of brimstone might be used for intoxicating the bees, with some few precautions. The heaviest and the lightest hives are alike treated in this manner; the former, because they yield the most profit, with an immediate return; and the latter, because they would not be able to survive the winter. Those hives, which weigh from 15 to 20 pounds, are thought to be the fittest for keeping. Various methods have also been adopted in England, to attain the desirable end of getting the honey and wax without destroying the bees; the most approved of which is Mr. Thorley's, who, in his "Inquiry into the Nature, Order, and Government of Bees," thinks colonies preferable to hives. He tells us, that he has in some summers taken two boxes filled with honey from one colony, and yet sufficient store has been left for their maintenance during the winter, each box weighing 40 pounds. His boxes are made of deal, and an octagon, being nearer to a sphere, is better than a square form; for as the bees, in winter, lie in a round body near the centre of the hive, a due heat is then conveyed to all the outparts. The dimensions which Mr. Thorley, after many years experience, recommends, for the boxes, are 10 inches in depth, and 12 or 14 inches in breadth in the inside.

The best and purest honey is that which is gathered in the first five or six weeks: and in boxes of less dimensions, we may take within a month, provided the season be favourable, a boxful of the finest honey. The top of the box should be made of an entire board, a full inch thick after it has been planed, and it should project on all sides, at least an inch beyond the dimensions of the box. In the middle of this top there must be a hole five inches square, for a communication between the boxes; this hole should be covered with a sliding shutter, of deal or elm, running easily in a groove over the back window. The eight pannels, nine inches deep, and three quarters of an inch thick when planed, are to be let into the top, so far as to keep them in their proper places, to be secured at the corners with plates of brass, and to be cramped with wires at the bottom, to keep them firm; for the heat in summer will try their strength. There should be a glass window behind, fixed in a frame, with a thin deal cover, two small brass hinges, and a button to fasten it. This window will be sufficient for inspecting the progress of the bees. Two brass handles, one on each side, are necessary to lift up the box; these should be fixed in with two thin plates of iron, near three inches long, so as to turn up and down, and put three inches below the top board, which is nailed close down with sprigs to the other parts of the box. Those who choose a frame within, to which the bees may fasten their combs, need only use a couple of deal sticks, of an inch square, placed across the box. One thing more, which perfects the work, is a passage four or five inches long, and less than half an inch deep, for the bees to go in and out at the bottom of the box. In keeping bees in colonies, a house is necessary, or at least a shade; without which the weather, especially the heat of the sun, would soon rend the boxes to pieces. The house may be made of any boards, but deal is the best; and it must be painted, to secure it from the weather. The length of it, for six colonies, should be full twelve and a half feet, and each colony should stand a foot distant from the other. It should be three and a half feet high, to admit four boxes one upon another; but if only three boxes are employed, two feet eight inches will be sufficient. Its breadth in the inside should be two feet. The best time to plant the colonies is, either in spring, with new stocks full of bees, or in summer, with swarms. If swarms are used, procure if possible two of the same day; hive them either in two boxes, or in a hive and a box; at night place them in the bee-house, one over the other, and with a knife and a little lime and hair stop close the mouth of the hive or upper box, so that not a bee may be able to go in or out but at the front door. Within a week or ten days, the combs will appear in the boxes; but if it be a hive, nothing can be seen till the bees have wrought down into the box. Never plant a colony with a single swarm. When the second box, or the box under the hive, appears full of bees and combs, it is time to raise the colony. This should be done in the dusk of the evening, and in the following manner:

Place the empty box, with the sliding shutter drawn back, behind the house, near the colony that is to be raised, and at nearly the height of the floor: then lifting up the colony as quickly as possible, let the empty box be put into the place where it is to stand, and the colony upon it; and shut up the mouth of the then upper box with lime and hair, as directed before. When, upon looking through the windows in the back of the boxes, the middle box appears full of combs, and a quantity of honey sealed up in it, the lowest box half full of combs, and few bees in the uppermost box, proceed thus: About five o'clock in the evening, drive close with the mallet the sliding shutter under the hive or box that is to be taken from the colony. If the combs are new, the shutter may be forced home without a mallet; but be sure it is close, that no bees may ascend into the hive or box to be removed. After this, shut close the doors of the house, and leave the bees thus cut off from the rest of their companions, for half an hour or more. In this space, having lost their queen, they will fill themselves with honey, and be impatient to be set at liberty.

If, in this interval, upon examining the box or boxes beneath, all appears to be quiet in them, it is a sign that the queen is there, and in safety. Afterwards raise the back part of the hive or box so far, by a piece of wood slipped under it, as to give the prisoners room to come out, and they will return to their fellows: then lifting the box from off the colony, and turning its bottom upmost, cover it with a cloth all night; and the next morning, when this cloth is removed, the bees that have remained in it will return to the colony. Thus a box of honey is procured, and all the bees are preserved.

Bees have various enemies; mice should be guarded against, by diminishing the entrance into the hives when the cold comes on, and the bees are less able to defend themselves; and the hives may be placed in such a manner, that it will be impossible for the mice to reach them. Spiders and caterpillars are very destructive to bees; two species of the latter, called the wax-worm, or wax-moth, and bee-worm; because they feed on wax, lay their eggs in the hive, which turn to maggots, that are very prejudicial to the bees. In consequence of the increasing depredations of these insects within a few years, the quantity of honey brought to our markets has materially decreased. Hives of bees that have swarmed more than once, and such as contain little honey, are most exposed to these insects; for the empty combs serve them for shelter, and the wax supplies them with food. These hives should be cleaned at least once a week; and the stools on which they rest, where the moths are laid by the bees, should be cleaned every morning. But they cannot be entirely destroyed, without taking away the infected hive, removing the Bees, and cleansing it of the moths, before it is restored to its former occupiers. Bees are often troubled with lice, which may be destroyed by strewing tobacco over them. The depredations of birds, and particularly of the king-bird (muscicapa tyrannus,) should be carefully prevented. Ants, wood-lice, and earwigs, are also enumerated among the enemies of the bees. Mr. Keys says, "the earwigs steal into the hives at night, and drag out bee after bee, sucking out their vitals, and leaving nothing but their skins or scalps, like so many trophies of their butchery." Wasps and hornets are also formidable enemies that bees have to encounter. See *Doddrige on the culture of Bees*, and also, APIARY, and APIS, of this work.

BEECH. See FAGUS.

BEER, a fermented liquor, made generally from some farinaceous grain, particularly from prepared barley or malt. The mode of making beer will be found under the article BREWING. It may be observed, that, during the scarcity of grain in this country, sugar, treacle, and melasses, were frequently used as a substitute for malt. We shall in this place describe a machine that has obtained pretty general use in the public-houses in and near the metropolis, *viz.* the

BEER *pump*. The plate explains the construction of a set of beer pumps, as made by Mr. Thomas Rowntree, engine-maker, Blackfriars road: the pumps are not of the common construction, but similar to that made use of in his extinguishing engine: they are double, and throw out the liquor at either motion of the handle. Figures 4 and 5 are two sections of a pump at right angles to each other: fig. 4 being a section through the dotted line A B, fig. 5: and fig. 5 a section through C D, fig. 4: the same letters are used in both figures E E: F F is a brass cylinder with a flanch, E E (dotted in fig. 5) in front: G G, fig. 4, is a cover screwed to the cylinder with a stuffing box *n* in the centre, to receive the spindle H: I is a partition in the cylinder, with a packing at *a*, to embrace the spindle, and make a tight joint, this has two valves, *b*, *d*, shutting downwards upon holes made in the partition: K is the suction pipe, bringing liquor to the lower division of the cylinder, but has no other communication with the upper, but the two valves, *b*, *d*: L is the piston fixed to the spindle, and fitting the cylinder tight all round, so as to divide the upper part into two other parts: *e*, *f*, are copper pipes, to convey the liquor from the upper half of the cylinder to a chamber N, and its return is prevented by valves *g*, *h*, on the ends of the pipes: O is the forcing pipe screwed to the chamber N; when the piston is moved by the handles on the end of its spindle towards *b*; for instance, the valve *b* will be shut, and the liquor on that side, finding no other passage, passes through the pipe *e* and valve *g*, and into the chamber N, and is conveyed by means of the force pipe O, where required: the same motion of the piston, enlarging the space on the side *d*, shut the valve *h* at the end of the pipe *f*, and formed a vacuum: the pressure of the atmosphere upon the surface of the liquor, in which the end of K is immersed, forces it through the pipes, opens the valve *d*, and restores the equilibrium. The operation is exactly the same when the piston is moved in the other direction from L to *d*: the liquor going to O through *f*, and coming from K through *b*. Three of these pumps are mounted in a frame, as shewn in figures 1 and 2, which is inclosed in a box, with a circular top A B, and the handles *a*, *b*, *c*, project through it: the suction-pipes *d*, *e*, *f*, go through the floor into the cellar below: the force-pipes from the top of the pumps are bent, and come through the side of the box where the pots are held to be filled: *h* is a small cistern to receive the waste, which is conveyed by a pipe to a waste butt in the cellar: the suction-pipes pass through the floor, and are carried along the ceiling until just over the butt; they are then bent down, and jointed to the cock drove into the butt in the usual manner: the pipes are of lead, half an inch bore, and very thin, so that they can be bent (without breaking) to reach any particular place; they are connected with the cock by a screw joint, shewn in fig. 3: A B is the brass cock; its outer end B cut into screw, and the bore enlarged to form a socket for a short brass pipe D, soldered to the leaden one: a piece of leather put between the end of the cock and the shoulder of D makes a tight joint; these are kept together by a collar E, embracing the shoulder of D, and screwing upon the end of the cock: *e* is a stub projecting from it, by which it is turned. The piston of the pump consists of three plates, figures 4 and 5: the middle one (which should be called the piston) is cast in a piece with the spindle, and fits the cylinder as true as possible without touching; then square pieces of leather are put on each side of the piston, to form the joint, and a thin plate of metal put on over the leathers, and screwed to the piston, (as shewn at L, fig. 4,) holds it all fast. The body of the piston, as we have said before, fits the cylinder as close as possible: the leathers are about an half inch bigger all round, so that, when they are put into the cylinder, their edges will turn up all round, and form a dish; and its elasticity, pressing against the cylinder, prevents any of the liquor getting through; the two outside plates must be the thickness of the leather less all round than the cylinder, and their use is, to keep the edges of the leather up against the cylinder, and to hold the four screws by which the leather is fastened. The back of the spindle opposite the piston must have a packing of hemp drove into the space *a* behind it, to make all tight, and the metal edges of the partition, I, should fit it as closely as possible to work free: the valves are pieces of leather fastened at one side of the hole, and a piece of brass is rivetted to them, to make them heavy enough to fall, and prevent the leather bending by the pressure of the column of liquor: the top of the cylinder at N is filed flat, and the chamber, which is a square prism, placed on it with leather between, and the lid is put on the upper part, and all screwed together by four long screws, going through the lid, and the corners of the chamber, and tapped into the cylinder below. When these valves want repairing, the four screws are taken out, and the lid can then be removed. To come at the valves *b*, *d*, the cylinder lid G G can be removed, by taking out five screws; the lid has a hole turned in its centre, which fits the spindle H as close as possible: the hole afterwards enlarges, and has a piece of leather (represented by the dark part, fig. 4,) bent into a cup, so as to embrace the spindle: the leather is kept in his place by a perforated screw *n*, tapped into a projecting part of the lid, and pressing on the leather; the suction-pipe K of the pump is joined to the leaden pipes by a screw joint, K, so that it can be separated, occasionally to remove the pump from the frame.

BEESTINGS, a term used by country-people for the first milk taken from a cow after calving.

BEET. See Beta.

BEETLE. See Scarabæus.

Beetle also denotes a wooden instrument for driving piles, &c.

It is likewise called a stamper, and by paviors a rammer.

BEGGAR, one who begs alms.

Beggars, pretending to be blind, lame, &c. found begging in the streets, are to be removed by constables; and if they refuse to be so removed, shall be publicly whipt.

BEGONIA, in botany, a genus of the Monoecia Polyandria class and order. Natural order of Holoracæ. Incertæ, Jussieu. Essential character: male calyx none; corolla many-petalled; stamens numerous. Female calyx none; corolla many-petalled, superior; capsule winged, many-seeded. There are 23 species. The whole plant in the Begonias is fleshy. The stem in most of the species is herbaceous; but some of them are stemless. They are natives of Asia and America, within the Tropics. Three species have been found on the islands near the coast of Africa, but none on that continent.

BEHMENISTS, in church history, a sect of Christians, who derive their name from Jacob Behmen, a German mystic and enthusiast, whose distinguishing tenets were, that man has the immortal spark of life which is common to angels and devils; that divine life of the light and spirit of God makes the difference between an angel and devil, the latter having distinguished this divine life in himself; but that man can only attain to the heavenly life of the second principle through the new birth of Jesus Christ: that the life of the third principle is of the external and visible world. Thus, the life of the first and third principles is common to all men, but the life of the second principle only to a true Christian or child of God. Behmen was a pious man, and his principles were adopted by our countryman William Law, a worthy divine of the church of England; but in general, to a bye-stander, the Behmenites seem to try how they can talk on religion so as not to be intelligible.

BEJARIA, in botany, so called in honour of a Spanish botanist, a genus of the Dodecandria Monogynia class and order. Natural order of Bicornes: Rhododendra, Jussieu. Essential character: calyx seven-cleft; petals seven; stamina fourteen; berry seven-celled, many-seeded. There are two species found in New Granada.

BEING, in metaphysics, includes not only whatsoever actually is, but whatsoever can be. The various kinds of beings have been referred into three distinct classes, and they have been considered as either substances or modes, finite or infinite, and natural, artificial, or moral. Natural beings are all those things that have a real and proper existence in the universe, and are considered as formed and ordained by God the Creator; such are men, beasts, trees, &c. Artificial beings are made by the contrivance or operations of men, whether they are of a more corporeal nature, such as houses, statues, &c. or whether they relate to intellectual matters, as words, sciences, verse, &c. Moral beings are those which belong to the conduct and government of intelligent creatures, or creatures endowed with understanding and volition, considered as lying under obligations to particular actions.

BELL, a well known machine, ranked by musicians among the musical instruments of percussion.

The metal is usually composed of three parts of copper and one part of tin. Its colour is greyish-white; it is very hard, sonorous, and elastic. The greater part of the tin may be separated by melting the alloy, and then pouring a little water on it. The tin decomposes the water, is oxidised, and thrown upon the surface. According to Swedenburg, the English bell-metal is usually made from the scoriæ of the brass gun foundry, melted over again. The proportion of tin in bell-metal varies. Less tin is used for church bells than clock-bells; and in small bells, as those of watches, a little zinc is added to the alloy. According to Gerbert, the conch of the East Indians is composed of tin and copper, in the same proportions as in bell-metal.

The constituent parts of a bell are, the body or barrel, the clapper on the inside, and the ear or cannon on which it hangs to a large beam of wood.

The sound of a bell consists in a vibratory motion of its parts, much like that of a musical chord. The stroke of the clapper must necessarily change the figure of the bell, and of a round make it oval; but the metal having a great degree of elasticity, that part will return back again which the stroke drove farthest off from the centre, and that even some small matter nearer the centre than before; so that the two parts, which before were extremes of the longest diameter, do then become those of the shortest: and thus the external surface of the bell undergoes alternate changes of figure, and by that means gives that tremulous motion to the air, in which the sound consists.

M. Perrault asserts, that the sound of the same bell is a compound of the sound of the several parts of it; so that where the parts are homogeneous, and the dimensions of the figure uniform, there is such a perfect mixture of all these sounds, as constitutes one uniform, smooth, even sound, and the contrary circumstances produce harshness. To confirm this, he observes the different tone of the bell, according to the part of it that is struck; and yet, strike it where you will, there is a motion of all the parts. He therefore considers bells as composed of an infinite number of rings, which have different tones, according to their different dimensions, as chords of different lengths have, which, when struck, the vibrations of the parts immediately struck determine the tone, being supported by a sufficient number of consonant tones in other parts.

It has been found by experience, that bells are heard further, if placed on plains, than on hills, and still farther in vallies than on plains; the reason of which may be easily comprehended, by considering, that the higher the sonorous body is, the medium is the rarer, and consequently receives the less impulse, and the vehicle is the less proper to convey it to a distance.

The bell-founders distinguish two sorts of proportions, *viz.* the simple and the relative. The simple proportions are those which ought to be between the several parts of a bell, and which experience has shewn to be necessary towards rendering is sweetly sonorous. The relative proportions are those which establish a requisite relation between one bell and another, so that their combined sounds may effect a certain determined harmony.

The use of bells is very ancient, as well as extensive. We find them among the Jews, Greeks, Romans, Christians, and Heathens, variously applied, as on the necks of men, beasts, birds, horses, sheep; but chiefly hung in buildings, either religious, as in churches, temples, and monasteries; or civil, as in houses, markets, baths; or military, as in camps and frontier towns.

When they were first invented, or who introduced them into the Christian church, is not at present known: but it appears that they were employed in the eastern church in the ninth century, when Urcus Patriciacus, Duke of Venice, made a present of a set to Michael, the Greek emperor, who built a tower to the church of Sancta Sophia, in which to hang them.

BELLARDIA, in botany, a genus of the Tetrandria Monogynia class and order: calyx four-cleft, superior; nectary with a four-lobed margin surrounding the style; capsule two-celled, many-seeded. One species, found at Cayenne.

BELLES *lettres*, generally considered as synonymous with polite literature; they include the origin and structure of the various kinds of language; of grammar, universal and particular, criticism, rhetoric; history in its several departments, and all the different kinds of poetry. Different authors have included different departments of literature under this general term. The reader may be referred to Blair's Lectures, as including almost every thing that is necessary for a student to be informed of on the subject. See Criticism, Grammar, Poetry, Rhetoric, &c.

BELLIS, in botany, *common daisy*, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ; Jussieu. Essential character: calyx hemispheric, with equal scales; seeds ovate, with no down; receptacle naked, conical. There are only two species, with many varieties; *viz.* B. perennis, or common daisy, is sufficiently distinguished by its perennial root, is a native of most parts of Europe in pastures; flowers almost all the year, and shuts up close every night, and in wet weather. The taste of the leaves is somewhat acrid: in some countries, however, it is used as a pot-herb. The roots have a penetrating pungency. It is ungrateful to cattle, and even to geese; it occupies therefore a large share of pasture lands, to the exclusion of grass and profitable herbs. B. annua is a low plant, seldom rising more than three inches high, with an upright stalk, having leaves on the lower part, but the upper part naked, and supporting a single flower like that of the common daisy, though smaller. Native of Sicily, Spain, about Montpelier, Verona and Nice.

BELLIUM, in botany, a genus of the Syngenesia Polygamia Superflua class and order. Natural order of Compositæ Discoideæ. Corymbiferæ, Jussieu. Essential character: calyx with equal leaflets; seeds conic, with a chaffy eight-leaved crown, and awned down; receptacle naked. There are only two species, *viz.* B. bellidioides, has the habit of the daisy, though it differs essentially from it in having a down to the seed. Native of Italy about Rome, and in the island of Majorca. B. minutum, is one of the smallest of plants. This plant, examined with a glass, appears to have hairs scattered over it. Native of the Levant.

BELLONIA, in botany, so named in honour of Pierre Belon, a famous French physician, a genus of the Pentandria Monogynia class and order. Natural order of Rubiaceæ, Jussieu. Essential character: corolla wheel-shaped; capsule one-celled, inferior, many-seeded, beaked with the calyx. There are but two species, *viz.* B. aspera, is a shrub ten or twelve feet in height, sending out many lateral branches; flowers in loose corymbs. This species is yet little known, and, according to Swartz, has been seen only by Plumier. It is very common in several warm islands in America.

BELLOWS, a machine so contrived as to agitate the air with great briskness, expiring and inspiring it by turns, and that only from enlarging and contracting its capacity.

This machine is used in chambers and kitchens, in forges, furnaces, and founderies, to blow up the fire; it serves also for organs and other pneumatic instruments, to give them a proper degree of air. All these are of various constructions, according to their different purposes, but in general they are composed of two flat boards, sometimes of an oval, sometimes of a triangular figure. Two or more hoops, bent according to the figure of the boards, are placed between them; a piece of leather, broad in the middle, and narrow at both ends, is nailed on the edges of the boards, which it thus unites together: as also on the hoops which separate the boards, that the leather may the easier open and fold again; a tube of iron, brass, or copper, is fastened to the undermost board, and there is a valve within that covers the holes in the under board, to keep in the air.

The action and effect of bellows of every kind, whether constructed of leather or wood, wrought by men, by steam, or by water, depends on this, that the air which enters them, and which they contain when raised, is again compressed into a narrower space when they are closed. As the air flows to that place where it meets with the least resistance, it must of necessity fly out of the pipe with a velocity proportional to the force by which it is compressed, and must therefore blow stronger or weaker, as the velocity with which the top and bottom of the bellows meet is greater or less. The blast will last in proportion to the quantity of air that was drawn into the bellows through the valve. The action of the bellows bears a near affinity to that of the lungs, and what is called blowing in the latter affords an illustration of what is called respiring in the former: hence bellows have been employed in restoring suspended animation. See Drowning.

The bellows of smiths, founders, &c. are worked by means of a rocker, with a string fastened to it, and pulled by the workman. One of the boards is fixed so as not to play at all. By drawing down the handle of the rocker, the moveable board rises, and by means of a weight on the top of the upper board sinks again. Large bellows used in founderies, &c. receive their motion from water wheels or steam: others that are small are worked by the feet of the men using them, as is the case with enamellers, jewellers, &c. The bellows of an organ are six feet long, and four feet broad, each having an aperture of four inches, that the valve may play easily. To blow an organ of sixteen feet, there are required four pair of these bellows.

BELLUÆ, in natural history, the sixth order of the class Mammalia. They are distinguished by fore-teeth, obtuse; feet hoofed; motion heavy; food vegetables. There are four genera, *viz.*

Equus.
Hippopotamus.
Sus.
Tapir.

BELLY, in anatomy, the same with what is more usually called abdomen, or rather the cavity of the abdomen. See Anatomy.

Belly *of an instrument*, in music, is that thin smooth board over which the strings in a harpsicord, piano-forte, &c. are distended, and which by the vibration contributes to the tone. In a violin, and other instruments performed with a bow, and in a guitar, it is that part of the body which lies immediately under the strings.

BELT, in the military art, a leathern girdle for sustaining the arms, &c. of a soldier.

BELTS, in astronomy, zones or girdles surrounding the planet Jupiter, brighter than the rest of his body, and terminated by parallel lines. They are observed, however, to be sometimes broader and sometimes narrower, and not always occupying exactly the same part of the disc. Jupiter's belts were first observed and described by Huygens. Dark spots have often been observed on the belts of Jupiter; and M. Cassini observed a permanent one on the northern side of the most southern belt, by which he determined the length of Jupiter's days, or the time in which the planet revolves upon its axis, which is $9^{h}\ 56^{m}$. Some astronomers suppose that these belts are seas, which alternately cover and leave bare large tracts of the planet's surface: and that the spots are gulphs in those seas, which are sometimes dry, and sometimes full. But Azout conceived that the spots are protuberances of the belts; and others again are of opinion that the transparent and moveable spots are the shadows of Jupiter's satellites.

Cassini also speaks of the belts of Saturn being three dark, straight parallel bands, or *fasciæ*, on the disc of that planet. But it does not appear that Saturn's belts adhere to his body, as those of Jupiter do; but rather that they are large dark rings surrounding the planet at a distance. Some imagine that they are clouds in the atmosphere of Saturn, though it would seem that the middlemost is the shadow of his ring.

Belts, in geography, certain straights between the German ocean and the Baltic. The belts belong to the King of Denmark, who exacts a toll from all ships which pass through them, excepting those of Sweden, which are exempted.

BELVIDERE, in the Italian architecture, &c. denotes either a pavilion on the top of a building, or an artificial eminence in a garden: the word literally signifying a fine prospect.

BEND, in heraldry, one of the nine honourable ordinaries, containing a third part of the field when charged, and a fifth when plain. It is sometimes, like other ordinaries, indented, ingrailed, &c. and is either dexter or sinister.

Bend *dexter* is formed by two lines drawn from the upper part of the shield on the right to the lower part of the left, diagonally. It is supposed to represent a shoulder belt, or a scarf, when worn over the shoulder.

Bend *sinister* is that which comes from the left side of the shield to the right: this the French heralds call a barre.

Bend *in* is when any things borne in arms are placed obliquely from the upper corner to the opposite lower, as the bend lies.

BENDING, in a general sense, the reducing a straight body into a curve, or giving it a crooked form.

The bending of timber, boards, &c. is effected by means of heat or steam, whereby their fibres are so relaxed that you may bend them into any figure.

Bending, in the sea-language, the tying two ropes or cables together; thus they say, bend the cable, that is, make it fast to the ring of the anchor; bend the sail, make it fast to the yard.

BENDS, in a ship, the same with what is called wails or wales; the outmost timbers of a ship's side, on which men set their feet in climbing up. They are reckoned from the water, and are called the first, second, or third bend. They are the chief strength of a ship's sides, and have the beams, knees, and foot-hooks bolted to them.

BENDY, in heraldry, is the field divided into four, six, or more parts, diagonally, and varying in metal and colour.

The general custom of England is to make an even number, but in other countries they regard it not, whether even or odd.

BENEFICE is generally taken for all ecclesiastical livings, be they dignities or not: all church preferments are benefices; but they must be given for life, and not for a term of years, or at will.

BENEFIT *of clergy*. By stat. 3 Ed. I. c. 3, it is enacted, that for the scarcity of clergy in the realm of England, to be disposed of in religious houses, or for priests, deacons, and clerks of parishes, there should be a prerogative allowed to the clergy, that if any man that could read as a clerk were to be condemned to death, the bishop of the diocese might, if he would, claim him as a clerk; and he was to see him tried in the face of the court if he could read or not; if the prisoner could read, then he was to be delivered over to the bishop, who should dispose of him in some places of the clergy, as he should think meet; but if either the bishop would not demand him, or the prisoner could not read, then he was to be put to death.

By the common law, a woman was not entitled to the benefit of clergy; but by 3 W. c. 9, s. 6, a woman convicted, or out-lawed, for any felony for which a man might have his clergy, shall, upon her prayer to have the benefit of this statute, be subject only to such punishment as a man would in a like case.

But every person (not being within orders,) who has been once admitted to his clergy, shall not be admitted to it a second time, 4 Hen. VII. c. 13; and against the defendant's plea of clergy, the prosecutor may file a counter plea, alleging some fact, which in law deprives the defendant of the privilege he claims; as he was before convicted of an offence, and therefore not entitled to the benefit of the statute.

In case of high treason against the king, clergy was never allowable.

When a person is admitted to his clergy, he forfeits all the goods he possessed at the time of the conviction, 2 H. H. 388. But immediately on his burning in the hand, he ought to be restored to the possession of his land, 2 H. H. 388. It also restores him to his credit, and consequently enables him to be a good witness.

BENEVOLENCE is used in the statutes of this realm for a voluntary gratuity given by the subjects to the king. This, instead of a gift, is an extortion and imposition, that has been guarded against by the declaration of rights, 1 Wm. 2 st. where it is insisted, that levying money for or to the use of the crown, by pretence of prerogative, without grant of parliament, is illegal.

BENZOATS, salts formed of the benzoic acid and alkalies and most of the earths. They are all soluble, and from them the acid may be separated by means of the muriatic acid. Many of the metallic oxides are soluble in this acid, but not the metals themselves. The benzoat of lime has been found in the urine of horses and some other quadrupeds: and to this is ascribed the sub-aromatic smell sometimes perceived from the liquid when fresh. The benzoats in chemical affinity follow this order:

Lime
Barytes
Magnesia
Potash
Soda
Ammonia
Alumina
Metallic oxides.

BENZOIN, in chemistry, a gum called gum Benjamin; is brought from the East Indies in brittle masses of unequal degrees of purity, and varying in colour from yellow to white. It has but little taste; but if previously dissolved, it is rather pungent and aromatic. Its smell is grateful when rubbed or warmed, and when the heat is increased the resin melts, a white and most fragrant vapour rises, which is easily condensed on the surrounding bodies into beautiful shining saline needles. These are what are denominated benzoic acid. Benzoin is very soluble in alcohol, but separates on the addition of water. It is one of the most important balsams in modern chemistry, which are considered as resins naturally united with that volatile christalizable acid which has just been mentioned, and which is the same in all natural balsams. The benzoic acid may be prepared either by sublimation or by digestion: that obtained by sublimation is remarkably light, feathery, and elastic. When pure it is quite white; for the yellowness is owing to its admixture with oil. This acid is contained in styrax and balsam of Tolu, giving them the characters of true balsams. It is likewise met with, but more sparingly, in several fragrant barks, resins, and other vegetable matters. It generally appears in its proper character when these substances are moderately heated; or it may be extracted with lime. Benzoic acid, or, as it is called in the shops, flowers of Benjamin, is the chief ingredient of the celebrated "pomade divine," of which, according to Dr. Beddoes, the composition is as follows:

	oz.	
Beef marrow	12	steeped in water ten days, and afterwards in rose-water 24 hours.
Flowers of Benjamin . . . . . . Pounded storax Florentine orris		of each ½ an ounce.
Cinnamon		¼ ounce.
Clove and nutmeg		¼ ditto.

The whole to be put in an earthen vessel, closely covered down to keep in the fumes, and being suspended in water made to boil three hours. After which the whole is to be strained and put in bottles.

BERBERIS, *barberry*, in botany, a genus of the Hexandria Monogynia class and order. Essential character: calyx six-leaved; petals six, with two glands at the claws; style none; berry two-seeded. There are four species, of which B. vulgaris, is a shrub rising to the height of eight or ten feet. It is a native of eastern countries, and found in most parts of Europe, in woods, coppices, and hedges. In England, chiefly in a chalky soil, as particularly about Saffron Walden in Essex. The leaves of this shrub are gratefully acid. The smell of the flowers is offensive when near, but pleasant at a certain distance. The berries are so very acid that birds seldom touch them. They are pickled and used for garnishing dishes; and being boiled with sugar, form a most agreeable jelly. The roots boiled in lye yield a yellow colour; and in Poland they dye leather of a fine yellow with the bark of the root. The inner bark of the stems also will dye linen of a fine yellow with the assistance of alum. Insects of various kinds are remarkably fond of the flowers of barberry. Linnæus observed long since, that when bees in search of honey touch the filaments, the anthers approximate to the stigma, and explode the pollen. Dr. Smith has given the following particular account of this curious phenomenon. The stamens of such flowers as are open bend back to each petal, and shelter themselves under their concave tips. No shaking of the branch has any effect upon them; but if the inside of the filaments be touched with a small stick, they instantly spring from the petal, and strike the anther against the stigma. The outside of the filament has no irritability, nor has the anther itself any; as may easily be proved by touching either of them with a blunt needle, a fine bristle, a feather, or any thing which cannot injure the structure of the part. If a stamen be bent to the stigma, by means of a pair of scissors applied to the anther, no contraction of the filament is produced. From all this it is evident, that the spring of the stamens is owing to an high degree of irritability in the side of the filament next the germ, by which, when touched, it contracts, that side becomes shorter than the other, and consequently the filament is bent towards the germ. This irritability is perceptible in all ages; in flowers only so far expanded as to admit a bristle; and in old flowers ready to fall off. If the germ be cut off, the filaments will still contract, and nothing being in their way, will bend over quite to the opposite side of the flower. After irritation, the stamens will return to their original place. On being touched, they will contract with the same facility as before; and this may be repeated three or four times. The purpose which this contrivance of nature answers is evident. In the original position of the stamens, the anthers are sheltered from rain by the concavity of the petals. Thus probably they remain, till some insect coming to extract honey from the base of the flower, thrusts itself between the filaments, and almost unavoidably touches them in the most irritable part: thus the impregnation of the germ is performed; and as it is chiefly in fine sunny weather that insects are on the wing, the pollen is also in such weather most fit for the purpose of impregnation.

BERCKHEYA, in botany, a genus of the Syngenesia Frustranea class and order. Receptacle chaffy; seeds hairy, crowned with chaff; calyx imbricate; florets of the ray hermaphrodite, with the stamina castrate. There are more than 20 species, natives of the Cape.

BEREANS, in church history, a sect of Christians who profess to follow the example of the ancient Bereans, in building their faith and practice upon the scriptures alone, without regard to any human authority whatever. The founder of this sect was Mr. Barclay, a Scotch clergyman.

BERGAMOT, the name of a fragrant essence, extracted from a fruit which is produced by ingrafting a branch of a lemon-tree upon the stock of a bergamot-pear.

BERGERA, in botany, so named from Berger, professor of Kiel, a genus of the Decandria Monogynia class and order. Essential character: calyx five-parted; petals five; berry sub-globular, one-celled, with two seeds. There is but one species; *viz.* B. koenigii. This is a very leafy tree, with the bark of alder. It is a native of the East Indies.

BERGIA, in botany, from Peter Jonas Bergius, professor of natural history at Stockholm, a genus of the Decandria Pentagynia class and order. Natural order of Succulentæ. Caryophylleæ, Juss. Essential characters; calyx five-parted; petals five; capsule one, globular with swellings, five-celled, five-valved; valves resembling petals: seeds very many. There are two species; *viz.* B. capensis, and B. glomerata: the stem of the former is extremely simple, half a foot high, the thickness of a pigeon's quill, erect, smooth, rather succulent. It is a native of Tranquebar, in the East Indies, and therefore is misnamed capensis. The valves of the capsule, continuing after it is ripe, form a kind of fine petalled wheel-shaped flower. The other species is found at the Cape.

BERGSEIFE, in mineralogy, *mountain-soap*, is of a brownish colour, and is found in mass, and disseminated. It is dull internally, and its fracture is fine-earthy, passing into flat conchoidal. It is opaque, does not stain the fingers, gives a resinous streak, is very soft, adheres powerfully to the tongue, and is light. It is found in rocks in Poland and Bohemia, where it is used for washing linen, and in the Isle of Skye in Scotland.

BERKELEY (George) the virtuous and learned bishop of Cloyne in Ireland, was born in that kingdom, at Kilcrin, the 12th of March, 1684. After receiving the first part of his education at Kilkenny school, he was admitted a pensioner of Trinity College, Dublin, at 15 years old; and chosen fellow of that college in 1707.

The first public proof he gave of his literary abilities was, "Arithmetica absque Algebra aut Euclide demonstrata;" which, from the preface, it appears he wrote before he was 20 years old, though he did not publish it till 1707. It is followed by a mathematical miscellany, containing observations and theorems inscribed to his pupil Samuel Molineux.

In 1709 came out the "Theory of Vision;" which of all his works, it seems, does the greatest honour to his sagacity; being, it has been observed, the first attempt that ever was made, to distinguish the immediate and natural objects of sight from the conclusions we have been accustomed from infancy to draw from them. The boundary is here traced out between the ideas of sight and touch; and it is shewn, that though habit hath so connected these two classes of ideas in the mind, that they are not without a strong effort to be separated from each other, yet originally they have no such connection; insomuch, that a person born blind, and suddenly made to see, would at first be utterly unable to tell how any object that affected his sight would affect his touch; and particularly would not from sight receive any idea of distance, or external space, but would imagine all objects to be in his eye, or rather in his mind.

In 1710 appeared "The Principles of Human Knowledge; and in 1713 "Dialogues between Hylas and Philonous:" the object of both which pieces is, to prove that the commonly received notion of the existence of matter is false; that sensible material objects, as they are called, are not external to the mind, but exist in it, and are nothing more than impressions made upon it by the immediate act of God, according to certain rules, termed laws of nature.

Acuteness of parts and beauty of imagination were so conspicuous in Berkeley's writings, that his reputation was now established, and his company courted; men of opposite parties concurred in recommending him. For Steele he wrote several papers in the Guardian, and at his house became acquainted with Pope, with whom he always lived in friendship. Swift recommended him to the celebrated Earl of Peterbourgh, who, being appointed ambassador to the King of Sicily and the Italian States, took Berkeley with him as chaplain and secretary in 1713, with whom he returned to England the year following.

His hopes of preferment expiring with the fall of Queen Anne's ministry, he some time after embraced an offer made him by Ashe, bishop of Clogher, of accompanying his son in a tour through Europe. In this he employed four years; and besides those places which fall within the grand tour, he visited some that are less frequented, and with great industry collected materials for a natural history of those parts, but which were unfortunately lost in the passage to Naples. He arrived at London in 1721; and being much affected with the miseries of the nation, occasioned by the South-sea scheme in 1720, he published the same year "An Essay towards preventing the ruin of Great Britain;" reprinted in his "Miscellaneous Tracts."

His way was now open into the first company. Pope introduced him to Lord Burlington, by whom he was recommended to the Duke of Grafton, then appointed Lord Lieutenant of Ireland, who took Berkely over as one of his chaplains in 1721. The latter part of this year he accumulated the degrees of bachelor and doctor of divinity; and the year following he had a very unexpected increase of fortune from the death of Mrs. Vanhomrigh, the celebrated Vanessa, to whom he had been introduced by Swift. This lady had intended Swift for her heir; but perceiving herself to be slighted by him, she left her fortune of 8,000*l.* between her two executors, of whom Berkeley was one. In 1724 he was promoted to the deanery of Derry, worth 1,100*l.* a year.

In 1732 he published "The Minute Philosopher," in two volumes 8vo., against Freethinkers. In 1733 he was made Bishop of Cloyne; and might have been removed in 1745, by Lord Chesterfield, to Clogher, but declined it. He resided constantly at Cloyne; where he faithfully discharged all the offices of a good bishop, yet continued his studies with unabated attention.

About this time he engaged in a controversy with the mathematicians, which excited much debate in the literary world; and the occasion of it was this: Addison had given the Bishop an account of the behaviour of their common friend Dr. Garth, in his last illness, which was equally unpleasing to both these advocates of revealed religion. For when Addison went to see the Doctor, and began to discourse with him seriouly about another world, "Surely, Addison," replied he "I have good reason not to believe those trifles, since my friend Dr. Halley, who has dealt so much in demonstration, has assured me, that the doctrines of christianity are incomprehensible, and the religion itself an imposture." The Bishop, therefore, took up arms against Halley, and addressed to him, as to an infidel mathematician, a discourse called "The Analyst;" with a view of shewing that mysteries in faith were unjustly objected to by mathematicians, who he thought admitted much greater mysteries, and even falsehoods in science, of which he endeavoured to prove that the doctrine of fluxions furnished a clear example. This occasioned a long controversy between himself and some eminent mathematicians.

In 1736 Bishop Berkeley published "The Querist," a discourse addressed to magistrates, occasioned by the enormous licence and irreligion of the times; and many other things afterwards of a smaller kind. In 1744 came out his celebrated and curious book, "Siris; a Chain of Philosophical Reflections and Inquiries concerning the virtues of Tar-water." July the same year he removed, with his lady and family, to Oxford, partly to superintend the education of a son, but chiefly to indulge the passion for learned retirement, which had always strongly possessed him. He would have resigned his bishopric for a canonry or headship at Oxford; but it was not permitted him. Here he lived highly respected, and collected and printed the same year all his smaller pieces in 8vo. But this happiness did not long continue, being suddenly cut off by a palsy of the heart, January 14, 1753, in the 69th year of his age, while listening to a sermon that his lady was reading to him. The excellence of Berkeley's moral character is conspicuous in his writings: he was an amiable as well as a very great man; and in many respects worthy the character given him by Pope:

"To Berkeley every virtue under heaven."

BERMILCH, in mineralogy, called the agaric mineral, is yellowish white, and is composed of slightly cohering very fine particles: it is dull, opaque, has a meagre feel, soils the fingers when handled, and so light as nearly to float in water. It effervesces, and is dissolved in acids, and appears to be a carbonate of lime. It is found in fissures of secondary limestone rocks in Switzerland, and at Sunderland in Durham.

BERNACLE. See ANAS.

BERNARD, (Dr. EDWARD) a learned astronomer, critic, and linguist, was born at Perry St. Paul, near Towcester, the 2d of May, 1638, and educated at Merchant-Taylor's school, and at St. John's college, Oxford. Having laid in a good fund of classical learning at school, in the Greek and Latin languages, he applied himself very diligently, at the university, to the study of history, the eastern languages, and mathematics, under the celebrated Dr. Wallis. In 1668 he went to Leyden to consult some Oriental manuscripts left to that university by Joseph Scaliger and Levin Warner, and especially the 5th, 6th, and 7th books of Apollonius's Conics, the Greek text of which is lost, and this Arabic version having been brought from the east by the celebrated Golius, a transcript of which was thence taken by Bernard, and brought with him to Oxford, with intent to publish it there with a Latin translation; but he was obliged to drop that design for want of encouragement. This, however, was afterwards carried into effect by Dr. Halley, in 1710, with the addition of the 8th book, which he supplied by his own ingenuity and industry.

At his return to Oxford, Bernard examined and collated the most valuable manuscripts in the Bodleian library. In 1669, the celebrated Christopher Wren, Savilian professor of astronomy at Oxford, having been appointed Surveyor-General of his Majesty's works, and being much detained at London by this employment, obtained leave to name a deputy at Oxford, and pitched upon Mr. Bernard, which engaged the latter in a more particular application to the study of astronomy. But in 1673 he was appointed to the professorship himself, which Wren was obliged to resign, as, by the statutes of the founder, Sir Henry Saville, the professors are not allowed to hold any other office either ecclesiastical or civil.

About this time a scheme was set on foot at Oxford, of collecting and publishing the ancient mathematicians. Mr. Bernard, who had first formed the project, collected all the old books published on that subject since the invention of printing, and all the manuscripts he could discover in the Bodleian and Savilian libraries, which he arranged in order of time, and according to the matter they contained; of this he drew up a synopsis or view; and, as a specimen, he published a few sheets of Euclid, containing the Greek text, and a Latin version, with Proclus's commentary in Greek and Latin, and learned scholia and corollaries. The synopsis itself was published by Dr. Smith, at the end of his life of our author, under the title of "Veterum Mathematicorum Græcorum, Latinorum, et Arabum, Synopsis." And at the end of it there is a catalogue of some Greek writers, whose works are supposed to be lost in their own language, but are preserved in the Syriac or Arabic translations of them.

Toward the latter end of his life he was much afflicted with the stone; yet, notwithstanding this, and other infirmities, he undertook a voyage to Holland, to attend the sale of Golius's manuscripts, as he had once before done at the sale of Heinsius's library. On his return to England, he fell into a languishing consumption, which put an end to his life the 12th of Januaay, 1696, in the 58th year of his age. He was the author of many valuable works.

BERNOULLI (JAMES,) a celebrated mathematician, born at Basil, the 27th of December, 1654. Having taken his degrees in that university, he applied himself to divinity, at the entreaties of his father, but against his own inclination, which led him to astronomy and mathematics. He gave very early proofs of his genius for these sciences, and soon became a geometrician, without a preceptor, and almost without books; for if one by chance fell into his hands, he was obliged to conceal it, to avoid the displeasure of his father, who designed him for other studies. This situation induced him to choose for his device, Phaeton driving the chariot of the sun, with these words, *Invito patre sidera verso*, "I traverse the stars against my father's will;" alluding particularly to astronomy, to which he then chiefly applied himself.

In 1676 he began his travels. When he was at Geneva, he fell upon a method to teach a young girl to write who had been blind from two months old. At Bourdeaux he composed universal gnomonic tables; but they were never published. He returned from France to his own country in 1680. About this time there appeared a comet, the return of which he foretold; and wrote a small treatise upon it. Soon after this he went into Holland, where he applied himself to the study of the new philosophy. Having visited Flanders and Brabant, he passed over to England; where he formed an acquaintance with the most eminent men in the sciences, and was frequent at their philosophical meetings. He returned to his native country in 1682; and exhibited at Basil a course of experiments in natural philosophy and mechanics, which consisted of a variety of new discoveries. The same year he published his "Essay on a new System of Comets;" and the year following, his "Dissertation on the Weight of the Air." About this time Liebnitz having published, in the Acta Eruditorum at Leipsic, some essays on his new "Calculus Differentialis," but concealing the art and method of it, Mr. Bernoulli and his brother John discovered, by the little which they saw, the beauty and extent of it; this induced them to endeavour to unravel the secret; which they did with such success, that Liebnitz declared that the invention belonged to them as much as to himself.

In 1687, James Bernoulli succeeded to the professorship of mathematics at Basil; a trust which he discharged with great applause; and his reputation drew a great number of foreigners from all parts to attend his lectures. In 1699, he was admitted a foreign member of the Academy of Sciences of Paris; and in 1701, the same honour was conferred upon him by the Academy of Berlin: in both of which he published several ingenious compositions, about the years 1702, 3, and 4. He wrote also several pieces in the "Acta Eruditorum" of Leipsic, and in the "Journal des Sçavans." His intense application to study brought upon him the gout, and by degrees a slow fever, which put a period to his life the 16th of August, 1705, in the 51st year of his age. Archimedes having found out the proportion of a sphere and its circumscribing cylinder, ordered them to be engraven on his monument. In imitation of him, Bernoulli appointed that a logarithmic spiral curve should be inscribed on his tomb, with these words, "Eadem mutata resurgo;" in allusion to the hopes of the resurrection, which are, in some measure, represented by the properties of that curve, which he had the honour of discovering.

James Bernoulli had an excellent genius for invention and elegant simplicity, as well as a close application. He was eminently skilled in all the branches of the mathematics, and contributed much to the promoting the new analysis, infinite series, &c. He carried to a great height the theory of the quadrature of the parabola; the geometry of curve lines, of spirals, of cycloids, and epicycloids. His works, that had been published, were collected, and printed in two volumes 4to. at Geneva, in 1744.

Bernoulli (John,) the brother of James, last mentioned, and a celebrated mathematician, was born at Basil the 7th of August, 1667. His father intended him for trade; but his own inclination was at first for the Belles-Lettres, which, however, like his brother, he left for mathematics. He laboured with his brother to discover the method used by Leibnitz, in his essays on the differential calculus, and gave the first principles of the integral calculus. Our author, with Messieurs Huygens and Leibnitz, was the first who gave the solution of the problem proposed by James Bernoulli, concerning the catenary or curve formed by a chain suspended by its two extremities.

John Bernoulli was a member of most of the academies of Europe, and received as a foreign associate of that of Paris in 1699. After a long life spent in constant study and improvement of all the branches of the mathematics, he died full of honours the 1st of January, 1748, in the 81st year of his age. Of five sons which he had, three pursued the same sciences with himself. One of these died before him; the two others, Nicolas and Daniel, he lived to see become eminent and much respected in the same sciences.

The writings of this great man were dispersed through the periodical memoirs of several academies, as well as in many separate treatises. And the whole of them were carefully collected and published at Lausanne and Geneva, 1742, in 4 volumes, 4to.

Bernoulli (Daniel), a celebrated physician and philosopher, and son of John Bernoulli last mentioned, was born at Groningen, February the 9th, 1700, where his father was then professor of mathematics. He was intended by his father for trade, but his genius led him to other pursuits. He passed some time in Italy; and at 24 years of age he declined the honour offered him of becoming president of an academy intended to have been established at Genoa. He spent several years with great credit at Petersburgh; and in 1733 returned to Basil, where his father was then professor of mathematics; and here our author successively filled the chair of physic, of natural and of speculative philosophy.

Daniel Bernoulli wrote a multitude of pieces, which have been published in the Memoirs of the Academy of Sciences at Paris, and in those of other academies. He gained and divided ten prizes from the Academy of Sciences, which were contended for by the most illustrious mathematicians in Europe. The only person who has had similar success, in the same line, is Euler, his countryman, disciple, rival, and friend. His first prize he gained at 24 years of age. In 1734 he divided one with his father, which hurt the family union; for the father considered the contest itself as a want of respect; and the son did not sufficiently conceal that he thought (what was really the case) his own piece better that his father's. And besides, he declared for Newton, against whom his father had contended all his life. In 1740, our author divided the prize, "On the Tides of the Sea," with Euler aud Maclaurin. The Academy at the same time crowned a fourth piece, the chief merit of which was that of being a Cartesian: but this was the last public act of adoration paid by the Academy to the authority of the author of the Vortices, which it had obeyed but too long. In 1748, Daniel Bernoulli succeeded his father John in the Academy of Sciences, who had succeeded his brother James; this place, since its first erection in 1699, having never been without a Bernoulli to fill it.

Our author was extremely respected at Basil; and to bow to Daniel Bernoulli, when they met him in the streets, was one of the first lessons which every father gave every child. He was a man of great simplicity and modesty of manners. He used to tell an anecdote, which he said had given him more pleasure than all the other honours he had received. Travelling with a learned stranger, who, being pleased with his conversation, asked his name; "I am Daniel Bernoulli," answered he, with great modesty; "And I," said the stranger (who thought he meant to laugh at him), "am Isaac Newton."

After a long, useful, and honourable life, Daniel Bernoulli died the 17th of March, 1782, in the 83d year of his age.

BERRY, a round fruit, for the most part soft, and covered with a thin skin, containing seeds in a pulpy substance; but if it be harder, or covered with a thicker skin, it is called pomum, apple.

BERTIERA, in botany, so named from M. Bertier, a genus of the Pentandria Monogynia class and order. Natural order of Contortæ, Linn. Bubiaceæ, Jussieu. Essential character: calyx turbinate, five-toothed; corol tube short, with a villose mouth; berry globose, inferior, two-celled, many-seeded. There is but one species, *viz.* B. guianensis. This is a shrub six or seven feet in height, the thickness of the human arm: branches opposite, knotty, tomentose. Corolla white, found in the wood of Anonna in Guiana, flowering and fruiting in the month of June.

BERYLL, in mineralogy, a species of the flint genus, divided by Werner into two sub-species. 1st, Precious beryll, which is green, passing on the one side into blue, and on the other into yellow; it is commonly mountain green and seladon; from the former it passes through various shades to the wine yellow; from the latter it passes into smalt, sky, and, in rare instances, into azure blue. Its colours are generally pale, sometimes two at once. It is crystallized in long equiangular six-sided prisms, which are perfect or truncated on the edges and angles. The crystals approach to trihedral, and sometimes to the oblique tetrahedral prisms: they are sometimes heaped on each other, the smaller ones being almost uppermost, thus forming a shape like a tower: and in other cases they are perforated in the direction of their axes. It is commonly transparent, but passing to the translucent, and is slightly duplicating. It is hard; scratches quartz; nearly equal in hardness to topaz, with which the mountain green variety has often been confounded. Easily frangible: and the specific gravity is 2.6 or 2.7. Before the blow-pipe it is difficultly fusible without addition, but with borax it melts easily: it is composed of

Silica	68.0
Alumina	15.0
Glucine	14.0
Lime	2.0
Oxide of iron	1.0
	100.0

It becomes very electrical by rubbing: is found in primitive rocks, accompanied with quartz, felspar, garnet, mica, fluor spar, and topaz. The most beautiful specimens are brought from China and the Brazils. They are also found in the Uralian mountains, in France, and in Saxony. When pure, it is cut into stones for rings and necklaces. Its plenty renders it of no great value. It was well known to the ancients, who procured it from several places where it is now found. It is mentioned by Pliny and others: the blue varieties were denominated sapphire; the green aqua marine, and the yellow topaz.

The 2d variety is denominated schorlous beryll, which is of a straw colour, passing to white, green, and yellow. The crystals are large, middle sized, and hard, but yielding to the file; it is brittle, and very easily frangible: specific gravity about 3.5. It melts with borax into a pure transparent glass, and consists of.

Silica	50
Alumina	50
	100

It is found embedded in quartz and mica, in many parts of Germany: it is the link that unites the precious beryll with schorl.

BESANT, or **Bezant**, a coin of pure gold, of an uncertain value, struck at Byzantium, in the time of the Christian emperors; from hence the gold offered by the king at the altar is called besant, or bisant.

Besants, in heraldry, round pieces of gold, without any stamp, frequently borne in coats of arms.

BESLERIA, in botany, a genus of the Didynamia Angiospermia class of plants. Its flower consists of a single ringent petal. Its fruit is a berry of a globose form, containing only one cell, in which are several seeds, very small, and of a roundish figure. There are six species.

BESORCH, a coin of tin, or some alloyed metal, current at Ormus, at the rate of $7\frac{7}{49}$ parts of a farthing sterling.

BETA, in botany, a genus of the Pentandria Digynia class and order. Natural order of Holoraceæ; Atriplices, Jussieu. Essential character: calyx five-leaved; corolla none; seed kidney-form, within the substance of the base of the calyx. There are four species, of which B. vulgaris, red garden beet, has large thick succulent leaves, which are for the most part of a dark red, or purple colour. The roots are large and deep red, and on these circumstances their goodness depends; for the longer they grow, the more tender they will be; and the deeper their colour, the more they are esteemed. Native of the sea coast of the southern parts of Europe. B. cicla, white garden beet, seldom grows larger than a man's thumb; the stalks grow erect, and have oblong, spear-shaped leaves, growing close to the stalk; the spikes of the flowers are axillary, long, and have narrow leaves placed between the flowers. The lower leaves are thick and succulent, and their foot-stalks are broad. For these it is cultivated; the leaves being boiled as spinach, or put into soups, and the stalks and midrib of the leaf being stewed and eaten as asparagus.

A large variety of this has lately been introduced from abroad, under the title of root of scarcity. It is much cultivated in many parts of the continent, not only in gardens, but in the fields; being much more in esteem, and perhaps really better than with us, where it seems to degenerate. The leaf and root are said to be excellent food for man and beast: it is affirmed not to be liable to destruction by insects; nor to be affected by drought. The leaves are recommended as equal in quality to spinach, and, being from thirty to forty inches long, and from twenty-two to twenty-five broad, exceed it greatly in quantity. They may also be gathered every twelve or fifteen days during the season. We are told, in the Gentleman's Magazine, that three varieties appeared from seeds procured from Dr. Lettsom. 1. With leaves and stem dark green, which was the most common. 2. With stem and leaves of a lighter colour, which he takes to be the white beet. 3. With stem and veins of the leaves red, which he says is the red beet. All of them have flowers in clusters, from two to three; pistils from two to five; a leaf growing from the base of the flowers; the segments of the calyx equal, hunched, and membranaceous at the edge; few plants flowering the first year, he concludes it to be biennial, as indeed all the garden sorts are, if not the wild sea beet also, although Linnæus sets it down as annual, and Ray as perennial. Dr. Lettsom, who took much pains to introduce the mangel wurzel, informs us, that on his own land, which was not favourable to its growth, the roots, upon an average, weighed full ten pounds, and if the leaves were calculated at half that weight, the whole product would be fifteen pounds of nutritious aliment upon every square of eighteen inches.

BETONY, *betonica*, in botany, a genus of the Didynamia Gymnospermia class of plants, whose flower, consisting of a single labiated petal, is of a bright red colour, and disposed in short spikes; the cup contains four ovated seeds. The species of this genus, of which there are seven, besides varieties, are herbaceous, fibrous rooted, hardy, perennial plants, and the stems are simple, or but little branched. The flowers are in whorls, forming a terminating spike. B. officinalis, wood betony, is a native of woods, heaths, and pastures among bushes, flowering from the beginning of July to September. Betony, says Linnæus, was formerly much used in medicine, but it is discarded from modern practice. When fresh, it intoxicates. The leaves, when dry, excite sneezing.

Sheep eat it, but goats refuse it. The leaves and flowers have an herbaceous, roughish, and somewhat bitterish taste, with a weak aromatic flavour. An infusion or light decoction of them may be drank as tea, or a saturated tincture in rectified spirit may be given in laxity and debility of viscera. The roots are bitter, and very nauseous; in a small dose they vomit and purge violently. This plant dies wool of a very fine dark yellow colour.

BETULA, the *birch-tree*, in botany, a genus of plants of the Monoecia Tetrandria class. The male flower is amentaceous, formed of a number of monopetalous floscules, each of which is divided into four parts. In the female flower the calyx is lightly divided into three segments: the fruit is a cylindric cone, and the seeds are on each side edged with a membrane. The alder, B. alnus, as well as the B. alba, belongs to this genus; but of all the species, we shall notice only the latter, or common birch-tree, which is known at first sight by the silvery colour of its bark, the smallness of the leaves, and the lightness and airiness of the whole appearance. It is of rather an inferior size among the forest trees. The branches are alternate, subdivided, very pliant and flexible, covered with a reddish brown or russet, smooth back, generally dotted with white. Leaves are alternate, bright green, smooth, shining beneath, with veins crossing like the meshes of a net; the petioles are half an inch or more in length, smooth, grooved above, and at the base are ovate green glands. The birch is a native of Europe, from Lapland to Italy, and of Asia, chiefly in mountainous situations, flowering with us in April and May. The twigs are erect in young trees, but being slender and pliant, they are apt to become pendent in old ones: hence there is a variety, B. pendula, as beautiful as the weeping willow. Another variety, named from Dalecarlia, where it is found, has leaves almost palmate, with segments toothed.

The B. alba, though the worst of timber, is highly useful for articles of small manufactures, as ox-yokes, bowls, dishes, ladles, and divers other domestic utensils. In America, they make their canoes, boxes, buckets, dishes, &c. from the birch: from an excrescence or fungus they form excellent touch-wood, and being reduced to powder, it is reckoned a specific for the piles. It is used as fuel, and will bear being burnt into excellent charcoal. The inner silken bark, which strips off of itself almost annually, was formerly used for writing, before the invention of paper. In Russia and Poland the coarser bark is used instead of tiles or slates for the covering of houses; and in almost all countries the twigs have been used by pedagogues to keep their pupils in order, and to maintain diligence and discipline in the schools; and also for brooms used in domestic economy. The bark is used in processes of dying; and in Scotland for tanning leather and making ropes. In Kamtschatka they form the bark into hats and drinking-cups.

The vernal sap of the birch-tree is made into wine. In the beginning of March, while the sap is rising, holes must be bored in the body of the tree, and fossets made of elder placed in them to convey away the liquid. If the tree be large, it may be tapped in several places at a time, and thus, according to the number of trees, the quantity of liquid is obtained. The sap is to be boiled with sugar in the proportion of four pounds to a gallon, and treated in the same way as other made wines. One great advantage attaching to the birch is, that it will grow on almost any barren ground: upon ground, says Martyn, that produced nothing but moss, birch-trees have succeeded, so as to produce at least 20*s.* per acre per ann. The broom-makers are constant customers for birch, in all places within 20 miles of the metropolis, or where water carriage is convenient; in other parts the hoop-benders are the purchasers; but the larger trees are consumed by turners, and the manufacturers of instruments of husbandry.

BEVEL, among masons, carpenters, joiners, and bricklayers, an instrument composed of two straight edges, or blades, attached at one end on a centre, as a rule joint, and may be set to any angle.

The make and use of this instrument is pretty much the same as those of the common square and mitre, except that those are fixed, the first at an angle of ninety degrees, and the second at forty-five: whereas the bevel being moveable, it may in some measure supply the place of both, which it is chiefly intended for, serving to set off, or transfer angles either greater or less than 90 or 45 degrees.

BEVILE, in heraldry, a thing broken or opening like a carpenter's rule: thus we say, he beareth argent, a chief bevile, vert, by the name of Beverlis.

BIBLE, *the book*, a name given by Christians, by way of eminence, to a collection of the sacred writings.

This collection of the sacred writings, containing those of the Old and New Testament, is justly looked upon as the foundation of the Jewish, as well as the Christian, religion. The Jews, it is true, acknowledge only the scriptures of the Old Testament, the correcting and publishing of which are unanimously ascribed, both by the Jews and the Christians, to Ezra. Some of the ancient fathers, on no other foundation than that fabulous and apocryphal book, the second book of Esdras, pretend that the scriptures were entirely lost in the Babylonish captivity, and that Ezra had restored them again by divine revelation. What is certain is, that in the reign of Josiah there were no other books of the law extant, besides that found in the temple by Hilkiah; from which original, that pious king ordered copies to be immediately written out, and search made for all the parts of the scriptures; by which means copies of the whole became pretty numerous among the people, who carried them with them into captivity. After the return of the Jews from the Babylonish captivity, Ezra got together as many copies as he could of the sacred writings, and out of them all prepared a correct edition, disposing the several books in their natural order, and settling the canon of the scripture for his time; having published them according to the opinion of most learned men in the Chaldee character, as the Jews upon their return from the captivity, brought with them the Chaldaic language, which from that time became their mother tongue, and probably gave birth to the Chaldee translation of their scriptures.

Bible, *Chaldee*, is only the glosses, or expositions made by the Jews, when they spoke the Chaldee tongue; whence it is called *targumim*, or paraphrases, as not being a strict version of the scriptures.

Bible, *Hebrew*. There is, in the church of St. Dominic, in Bononia, a copy of the Hebrew scriptures, which they pretend to be the original copy, written by Ezra himself. It is written in a fair character, upon a sort of leather, and made up into a roll, after the ancient manner; but its having the vowel points annexed, and the writing being fresh and fair, without any decay, are circumstances which prove the novelty of the copy.

Bible, *Greek*. It is a dispute among authors, whether there was a Greek version of the Old Testament, more ancient than that of the 72 Jews employed by Ptolemy Philadelphus to translate that book: before our Saviour's time, there was no other version of the Old Testament besides that which went under the name of the LXX.

But, after the establishment of Christianity, some authors undertook new translations of the Bible, under pretence of making them more conformable to the Hebrew text. There have been about six of these versions, some of which are charged with having corrupted several passages of the prophets relating to Jesus Christ; others have been thought too free in their versions; and others have been found fault with, for having confined themselves too servilely to the letter.

Bible, *Latin*. It is beyond dispute, that the Latin churches had, even in the first ages, a translation of the Bible in their language, which being the vulgar language, and consequently understood by every body, occasioned a vast number of Latin versions. Among these there was one which was generally received, and called, by St. Jerom, the vulgar or common translation. St. Austin gives this version the name of the Italic, and prefers it to all the rest. See Vulgate.

There were several other translations of the Bible into Latin, the most remarkable of which are, the versions of St. Jerom, Santes Pagninus, Cardinal Cajetan, and Isiodore Clarius, all from the Hebrew text. Besides these translations by Catholic authors, there are some made by Protestant translators of the Hebrew; the most eminent of their versions are those of Sebastian Munster, Leo Juda, Sebastian Castalio, Theodore Beza, Le Clerc, &c.

Bible *Syriac*. The Syrians have in their language a version of the Old Testament, which they pretend to be of great antiquity, most part of which they say was made in Solomon's time, and the rest in the time of Abgarus king of Edessa.

Bible, *Arabic*. The Arabic versions of the Bible are of two sorts, the one done by Christians, the other by Jews. There are also several Arabic versions of particular books of scripture, as a translation of the Pentateuch from the Syriac, and another of the same from the Septuagint, and two other versions of the Pentateuch, the manuscripts of which are in the Bodleian library.

The Gospel being preached in all nations, the Bible, which is the foundation of the Christian religion, was translated into the respective languages of each nation; as the Egyptian or Coptic, the Indian, Persian, Arminian, Ethiopic, Scythian, Sarmatian, Sclavonian, Polish, Bohemian, German, English, &c.

The books of the Bible are divided by the Jews into three classes, *viz.* the law, the prophets, and the hagiographers; a division which they are supposed to borrow from Ezra himself.

Each book is subdivided into sections, or *parasches*; which some maintain to have been as old as Moses, though others, with more probability, ascribe it to the same Ezra. These were subdivided into verses, *pesuchim*, marked in the Hebrew Bible by two great points, called *soph pasuch*, at the end of each. For the division of the Bible into chapters, as we now have it, is of much later date.

Divers of the ancient Bible-books appear to be irrecoverably lost, whether it be that the copies of them perished, or that Ezdras threw them out of his canon. Hence it is, that in the books still extant, we find divers citations of, and references to, others, which are now no more; as the book of Jasher, the book of the wars of the Lord, annals of the kings of Judah and Israel, part of Solomon's three thousand proverbs, and his thousand and five songs, besides his books on plants, animals, fishes, insects, &c. To which may be added, a book of Jeremiah, wherein he enjoined the captives, who went to Babylon, to take the sacred fire and conceal it; also the precepts which that prophet gave the Jews, to preserve themselves from idolatry, and his lamentations on the death of king Josiah.

The Jewish canon of scripture then was settled by Ezra; yet not so, but that several variations have been since made in it: Malachi, for instance, could not be put in the Bible by him, since that prophet is allowed to have lived after Ezra; nor could Nehemiah be there, since mention is made in that book of Juddua, as high priest, and of Darius Codomannus as king of Persia, who were at least an hundred years later than Ezra. It may be added, that, in the first book of Chronicles, the genealogy of the sons of Zerubbabel is carried down for so many generations, as must necessarily bring it to the time of Alexander; and consequently this book could not be in the canon in Ezra's days. It is probable the two books of Chronicles, Ezra, Nehemiah, Esther, and Malachi, were adopted into the Bible in the time of Simon the Just, the last of the men of the great synagogue.

Bibles, *English-Saxon*. If we inquire into the versions of the Bible of our own country, we shall find that Adelm, bishop of Shireborn, who lived in 709, made an English-Saxon version of the Psalms; and that Eadfrid, or Ecbert, bishop of Lindisferne, who lived about the year 730, translated several of the books of scripture into the same language. It is said likewise, that venerable Bede, who died in 785, translated the whole Bible into Saxon. But Cuthbert, Bede's disciple, in the enumeration of his master's works, speaks only of his translation of the Gospels, and says nothing of the rest of the Bible. Some pretend, that King Alfred, who lived in 890, translated a great part of the Scriptures. We find an old version in the Anglo-Saxon of several books of the Bible, made by Elfric, abbot of Malmesbury: it was published at Oxford in 1699. There is an old Anglo-Saxon version of the four Gospels, published by Matthew Parker, Archbishop of Canterbury, in 1571, the author whereof is unknown. Dr. Mill observes, that this version was made from a Latin copy of the old Vulgate.

Bibles, *Saxon*. The whole scripture is said by some to have been translated into the Anglo-Saxon by Bede, about the year 701, though others contend he only translated the Gospels. We have certain books or parts of the Bible, by several other translators; as, 1. The Psalms, by Adelm, bishop of Shireborn, contemporary with Bede; though by others this version is attributed to King Alfred, who lived 200 years after. Another version of the Psalms in Anglo-Saxon was published by Spelman, in 1640. 2. The Evangelists, still extant, done from the ancient Vulgate, before it was revised by St. Jerome, by an author unknown, and published by Matth. Parker, in 1571. An old Saxon version of several books of the Bible, made by Elfric, abbot of Malmesbury, several fragments of which were published by William Lilly, in 1638, the genuine copy by Edm. Thwaites, in 1639, at Oxford.

Bibles, *Indian*. A translation of the Bible into the North American Indian language, by Elliot, was published in 4to. at Cambridge in 1685.

Bibles, *English*. The first English Bible we read of was that translated by J. Wickliffe, about the year 1360; but never printed, though there are MS. copies of it in several of the public libraries. J. de Trevisa, who died about the year 1398, is also said to have translated the whole Bible; but whether any copies of it are remaining does not appear.

Tindal's. The first printed Bible in our language was that translated by Will. Tindal, assisted by Miles Coverdale, printed abroad in 1526; but most of the copies were bought up and burnt by Bishop Tunstal and Sir Thomas More. It only contained the New Testament, and was revised and republished by the same person in 1530. The prologues and prefaces added to it reflect on the bishops and clergy; but this edition was also suppressed, and the copies burnt. In 1532, Tindal and his associates finished the whole Bible, except the Apocrypha, and printed it abroad; but while he was afterwards preparing for a second edition, he was taken up and burnt for heresy in Flanders.

Matthews's. On Tindal's death, his work was carried on by Coverdale, and John Rogers, superintendant of an English church in Germany, and the first martyr in the reign of Queen Mary, who translated the Apocrypha, and revised Tindal's translation, comparing it with the Hebrew, Greek, Latin, and German, and adding prefaces and notes from Luther's Bible. He dedicated the whole to Henry VIII. in 1537, under the borrowed name of Thomas Matthews; whence this has been usually called Matthews's Bible. It was printed at Hamburgh, and licence obtained for publishing it in England, by the favour of Archbishop Cranmer, and the Bishops Latimer and Shaxton.

Cranmer's. The first Bible printed by authority in England, and publicly set up in churches, was the same Tindal's version revised, compared with the Hebrew, and in many places amended, by Miles Coverdale, afterwards Bishop of Exeter; and examined after him by Archbishop Cranmer, who added a preface to it: whence this was called Cranmer's Bible. It was printed by Grafton, of the largest volume, and published in 1540; and, by a royal proclamation, every parish was obliged to set one of the copies in their church, under the penalty of forty shillings a month: yet, two years after, the Popish bishops obtained its suppression of the king. It was restored under Edward VI. suppressed again under Queen Mary, and restored again in the first year of Queen Elizabeth, and a new edition of it given in 1562.

Geneva. Some English exiles at Geneva, in Queen Mary's reign, Cloverdale, Goodman, Gilbie, Sampson, Cole, Whittingham, and Knox, made a new translation, printed there in 1560, the New Testament having been printed in 1557, hence called the Geneva Bible, containing the variations of readings, marginal annotations, &c. on account of which it was much valued by the Puritan party in that and the following reigns.

Bishop's. Archbishop Parker resolved on a new translation for the public use of the church, and engaged the bishops and other learned men to take each a share or portion. These being afterwards joined together, and printed with short annotations in 1568, in a large folio, made what was afterwards called the great English Bible, and commonly the Bishop's Bible. The following year it was also published in octavo, in a small, but fine black letter, and here the chapters were divided into verses; but without any breaks for them, in which the method of the Geneva Bible was followed, which was the first English Bible where any distinction of verses was made. It was afterwards printed in large folio, with corrections, and several prolegomena, in 1572: this is called Matthew Parker's Bible. The initial letters of each translator's name were put at the end of his part: *e. gr.* at the end of the Pentateuch, W. E. for William Exon; that is, William, Bishop of Exeter, whose allotment ended there: at the end of Samuel, R. M. for Richard Menevensis, or Bishop of

St. David's, to whom the second allotment fell: and the like of the rest. The archbishop foresaw, directed, examined, and finished the whole. This translation was used in the churches for 40 years, though the Geneva Bible was more read in private houses, being printed above 30 times in as many years. King James bore it an inveterate hatred on account of the notes, which, at the Hampton court conference, he charged as partial, untrue, seditious, &c. The Bishop's Bible, too, had its faults. The king frankly owned he had yet seen no good translation of the Bible in English; but he thought that of Geneva the worst of all.

Rhemish. After the translation of the Bible by the bishops, two other private versions had been made of the New Testament: the first by Laurence Thomson, made from Beza's Latin edition, together with the notes of Beza, published in 1582, in 4to., and afterwards in 1589, varying very little from the Geneva Bible; the second by the Papists at Rheims, in 1584, called the Rhemish Bible, or Rhemish translation. These, finding it impossible to keep the people from having the Scriptures in the vulgar tongue, resolved to give a version of their own, as favourable to their cause as might be. It was printed on a large paper, with a fair letter and margin. One complaint against it was, its retaining a multitude of Hebrew and Greek words untranslated, for want, as the editors express it, of proper and adequate terms in the English to render them by, as the words *azymes, tunike, rational, holocaust, prepuce, pasche, &c.* However, many of the copies were seized by the Queen's searchers, and confiscated; and Thomas Cartwright was solicited by Secretary Walsingham to refute it: but, after a good progress made therein, Archbishop Whitgift prohibited his further proceeding therein, as judging it improper that the doctrine of the Church of England should be committed to the defence of a Puritan, and appointed Dr. Fulke in his place, who refuted the Rhemists with great spirit and learning. Cartwright's refutation was also afterwards published in 1618, under Archbishop Abbot. About 30 years after their New Testament, the Roman Catholics published a translation of the Old at Doway, in 1609 and 1610, from the Vulgate, with annotations; so that the English Roman Catholics have now the whole Bible in their mother tongue; though it is to be observed, they are forbidden to read it without a license from their superiors.

King James's. The last English Bible was that which proceeded from the Hampton-court conference, in 1603, where many exceptions being made to the Bishop's Bible, King James gave orders for a new one; not, as the preface expresses it, for a translation altogether new, nor yet to make of a bad one a good one; but to make a good one better, or of many good ones one best. Fifty-four learned persons were appointed for this office by the king, as appears by his letter to the archbishop, dated in 1604; which being three years before the translation was entered upon, it is probable seven of them were either dead, or had declined the task, since Fuller's list of the translators makes but 47; who, being ranged under six divisions, entered on their province in 1607. It was published in 1613, with a dedication to James, and a learned preface, and is commonly called King James's Bible. After this, all the other versions dropped and fell into disuse, except the Epistles and Gospels in the Common Prayer Book, which were still continued according to the Bishop's translation till the alteration of the liturgy in 1661, and the Psalms and Hymns, which are to this day continued as in the old version. The judicious Selden, in his Table Talk, speaking of the Bible, says, "The English translation of the Bible is the best translation in the world, and renders the sense of the original best, taking in for the English translation the Bishop's Bible as well as King James's. The translators in King James's time took an excellent way. That part of the Bible was given to him who was most excellent in such a tongue, (as the Apocrypha to Andrew Downs,) and then they met together, and one read the translation, the rest holding in their hands some Bible, either of the learned tongues, or French, Spanish, Italian, &c. If they found any fault, they spoke; if not, he read on." King James's Bible is that now read by authority, in all the churches in Britain.

Bibles, *Welsh.* There was a Welsh translation of the Bible made from the original in the time of Queen Elizabeth, in consequence of a bill brought into the House of Commons for this purpose in 1563. It was printed in folio in 1588. Another version, which is the standard translation for that language, was printed in 1620. It is called Parry's Bible. An impression of this was printed in 1690, called Bishop Loyd's Bible. These were in folio. The first 8vo. impression of the Welsh Bible was made in 1630.

Bibles, *Irish*. Towards the middle of the sixteenth century, Bedell, Bishop of Kilmore, set on foot a translation of the Old Testament into the Irish language; the New Testament and the Liturgy having been before translated into that language. The Bishop appointed one King to execute this work, who, not understanding the Oriental languages, was obliged to translate it from the English. This work was received by Bedell, who, after having compared the Irish translation with the English, compared the latter with the Hebrew, the LXX. and the Italian version of Diodati. When this work was finished, the bishop would have been himself at the charge of the impression, but his design was stopped, upon advice given to the Lord Lieutenant and the Archbishop of Canterbury, that it would prove a shameful thing for a nation to publish a Bible translated by such a despicable hand as King. However, the manuscript was not lost, for it went to press in the year 1685.

Bibles, *Erse*. There is also a version of the Bible in the Gaelic, or Erse language, published at Edinburgh.

BIDENS, in botany, a genus of the Syngenesia Polygamia Æqualis class of plants. The compound flower is uniform and tubulose, and the proper one infundibuliform. The seed is single, obtuse, and crowned with two or more erect and sharp awns. There are 14 species, most of which are herbaceous annuals. Some however are shrubs. Leaves generally opposite, some pinnate. Flowers axillary or terminating. B. tripartita is obviously distinguished from B. cernua, drooping water hemp agrimony, by its trifid leaves, a character more to be depended on than the uprightness of its flowers. It is also much more common with us at least. That is generally found in water; this more frequently occurs on the borders of ponds, rivulets, &c. where it flowers in August and September. This plant dyes a deep yellow. The yarn or thread must be first steeped in alum water, then dried and steeped in a decoction of the plant, and afterwards boiled in the decoction. The seeds have been sometimes known to destroy gold-fish, by adhering to their gills and jaws.

BIENNIAL *plants*, in botany, such as are of two years duration. Of this kind there are numerous plants, which being raised one year from seed, generally attain perfection in the same year, shooting up stalks, producing flowers, and perfecting seeds in the following spring or summer, and soon after perish.

BIGAMY, in law, is where a person marries a second wife or husband, the first being alive, for which the punishment was formerly death, as in cases of felony; but it is now usually punished with a long imprisonment, or even transportation; and in the case of a spy, employed by government in the year 1794, who was convicted of bigamy, the punishment was the mere residence in the house of the jailer for a very few days.

BIGNONIA, the *trumpet-flower*, in botany, a genus of the Didynamia Angiospermia class. The flower is monopetalous, with a mouth campanulated, and divided into five segments: the fruit is a pod with two cells and two valves, containing several imbricated, compressed, and winged seeds. There are 27 species, mostly trees and shrubs, inhabitants of the hot climates of the East and West Indies, and eminently beautiful. Flowers in panicles, large and handsome, of various colours, red, blue, yellow, or white. The calyx should be observed, whether it be simple or double; the corolla, whether it be regular or irregular; the stamens, whether they be fertile or barren; the fruit, whether it be bony or capsular, in form of a silique or ovate. B. catalpa is a deciduous tree, rising with an upright stem, covered with a smooth brown bark, to the height of thirty or forty feet: it sends out many strong lateral branches, having very large heart-shaped leaves on them, placed opposite at every point. The flowers are succeeded by long taper pods; but these have not yet been produced in England; it is found growing naturally on the back of South Carolina, at a great distance from the English settlements. It is now not uncommon in our nurseries and plantatioos. This tree has a good effect when it stands in the middle of large openings, where it can freely send forth its side branches, and shew itself to advantage. It flowers in August, and is known in the nurseries by its Indian name Catalpa.

BILBOES, a punishment at sea, answering to the stocks at land. The offender is laid in irons, or stocks, which are more or less ponderous, according to the quality of the offence of which he is guilty.

BILDGE of a ship, the bottom of her floor, or the breadth of the place the ship rests on when she is aground. Therefore, bildge-water is that which lies on her floor, and cannot go to the well of the pump: and bildge-pumps, or burr-pumps, are those that carry off the bildge-water. They likewise say the ship is bildged, when she has some of her timber struck off on a rock or anchor, and springs a leak.

BILDSTEIR, a mineral called by Klaproth Agalmatolite, of which there are two varieties. The first is semitransparent, its colour is olive and asparagus green, passing into greenish grey, internally it is shining, and has a greasy lustre: its parallel fracture is obscurely slaty, its cross fracture is small splintery passing to compact uneven: it is translucid, soft, and has a greasy feel. Specific gravity 2.81: according to Klaproth it contains,

Silex	54
Alumina	36
Oxide of iron	0.75
Water	5.50
Loss	3.75
	100.00

The second variety is opaque, and is of a reddish white passing into flesh-red, and variegated with different coloured veins: it possesses little or no lustre, and has a compact fracture; it consists of

Silex	62
Alumina	24
Lime	1
Oxide of iron	0.5
Water	10.0
Loss	2.5
	100.0

Bildsteir comes from China, and is the substance of which the little Chinese ornaments and figures of chimney-pieces are made.

BILE is a liquid of a yellowish-green colour, an unctuous feel, bitter taste, and peculiar smell, which is secreted by the liver; and in most animals considerable quantities of it are usually found collected in the gall bladder. Great attention has been paid to this liquid by physicians; because the ancients were accustomed to ascribe a very great number of diseases, and even affections of the mind, to its agency. The specific gravity of bile seems to vary, like that of all other animal fluids. When strongly agitated, it lathers like soap; and for this reason, as well as from a medical theory concerning its use, it has been often called an animal soap. It mixes readily with water in any proportion, and assumes a yellow colour; but it refuses to unite with oil when the two fluids are agitated together; the instant that they are left at rest the oil separates, and swims on the surface. Bile, however, dissolves a portion of soap readily, and is often employed to free cloth from greasy spots. When muriatic acid is poured upon bile, let it be ever so fresh, an odour of sulphureted hydrogen gas is constantly exhaled. When on 100 parts of ox bile, 4 parts of strong muriatic acid are poured, the whole instantly coagulates; but in some hours the greater part becomes again fluid; and when passed through the filtre, it leaves 0.26 of a white matter, which has all the properties of albumen. Thenard, by a careful and repeated analysis of ox bile, found that 800 parts of it yielded the following ingredients:

Water	700
Resin	43
Saccharine matter	41
Albumen	4
Soda	4
Muriate of soda	3.2
Sulphate of soda	0.8
Phosphate of soda	2.0
Phosphate of lime	1.2
Oxide of iron	0.5
	799.7

When bile is distilled in a water-bath, it affords a transparent watery liquor, which contracts a pretty strong odour, not unlike that of musk or amber, especially if the bile has been kept for some days before it is submitted to distillation.

Bile, exposed to a temperature between 65° and 75°, soon loses its colour and viscidity, acquires a nauseous smell, and deposits whitish mucilaginous flakes. After the putrefaction has made considerable progress, its smell becomes sweet, and resembles amber. If bile be heated, and slightly concentrated by evaporation, it may be kept for many months without alteration.

The principal use of the bile seems to be, to separate the excrement from the chyle, after both have been formed, and to produce the evacuation of the excrement out of the body. It is probable that these substances would remain mixed together, and that they would perhaps even be partly absorbed together, were it not for the bile, which seems to combine with the excrement, and by this combination to facilitate its separation from the chyle, and thus to prevent its absorption. Fourcroy supposes that the bile, as soon as it is mixed with the contents of the intestinal canal, suffers a decomposition; that its alkali and saline ingredients combine with the chyle, and render it more liquid, while its albumen and resin combine with the excrementitious matter, and gradually render them less fluid. From the late experiments of Berzelius on feces, it cannot be doubted that the constituents of the bile are to be found in the excrementitious matter; so that the ingenious theory of Fourcroy is so far probable. The bile also stimulates the intestinal canal, and causes it to evacuate its contents sooner than it otherwise would do; for when there is a deficiency of bile, the body is constantly costive.

BILINGUIS, in a general sense, signifies one that speaks two languages; but in law it is used for a jury that passes in any case between an Englishman and a foreigner, whereof part ought to be English and part strangers.

BILL, an instrument made of iron, edged in the form of a crescent, and adapted to a handle. It is used by plumbers, to perform several parts of their work; by basket-makers, to cut the largest pieces of chesnut trees, and other wood; and by gardeners, to prune trees. When short, it is called a hand-bill, and when long, a hedge-bill.

Bill *in trade*, both wholesale and retail, as also among workmen, signifies an account of merchandizes or goods delivered to a person, or of work done for one. In those bills must be set down the sums of money received on account, which ought to be deducted from the sum total.

Bill *of credit*, that which a merchant or banker gives to a person whom he can trust, impowering him to receive money from his correspondents in foreign countries. Though bills of credit be different from bills of exchange, yet they enjoy the same privileges; for the money paid in consequence of them is recoverable by law.

Bill *of entry*, an account of the goods entered at the custom-house, both inwards and outwards. In this bill must be expressed, the merchant exporting or importing; the quantity of merchandize, and the divers species thereof; and whither transported, or from whence.

Bill *of exchange*, a piece of paper, on which is written a short order, given by a merchant, &c. for paying to such a person, or his order, and in some countries to the bearer, in a distant place, a sum of money equivalent to that which such a merchant, &c. has received in his dwelling-house.

Bill *of lading*, an acknowledgment signed by the master of a ship, and given to a merchant, &c. containing an account of the goods which the master has received on board from that merchant, &c. with a promise to deliver them at an intended place for a certain salary. Each bill of lading must be treble, one for the merchant who loads the goods, another to be sent to the person to whom they are consigned, and the third to remain in the hands of the master of the ship.

Bill *of parcels*, an account given by the seller to the buyer, containing the particulars of all the sorts, and prices of the goods bought.

Bill *of sale*, is when a person, wanting a sum of money, delivers goods as a security to the lender, to whom he gives this bill, impowering him to sell the goods, in case the sum borrowed is not repaid, with interest, at the appointed time.

Bill *of store*, a licence granted at the custom-house to merchants, by which they have liberty to carry, custom-free, all such stores and provisions, as they may have occasion for during their voyage.

Bill *of sufferance*, a licence granted to a merchant at the custom-house, suffering him to trade from one English port to another, without paying custom.

Bill, *bank*, a private instrument, whereby private persons become entitled to a part in the bank stock.

Bill, in law, a security for money, under the hand, and sometimes the seal, of the debtor. It is of two sorts, a single bill without a penalty, or a bill with a penalty, called a penal bill; which last is all one with what we call a bond or obligation, only it has not a condition.

Bill denotes also a declaration, in writing, expressing either some wrong the complainant has suffered by the defendant, or else a fault that the party complained of has committed against some law or statute of the realm.

This bill is sometimes exhibited to justices at the general assises, by way of indictment, or referred to others having jurisdiction; but more especially is addressed to the lord-chancellor, for inconscionable wrongs done. It contains the thing or fact complained of, the damage sustained, and a petition or process against the defendant for redress; and is used both in criminal and civil cases. In a criminal case, the words BILLA VERA are indorsed by the grand jury upon a presentment, thereby signifying, that they find the same made with probable evidence, and on that account worthy of further consideration.

Bill *in parliament*, a paper containing propositions offered to the Houses to be passed by them, and then presented to the King to pass into a law. To bring a bill into the House, if the relief sought by it is of a private nature, it is first necessary to prefer a petition; which must be presented by a member, and usually sets forth the grievance desired to be remedied. This petition (when founded on facts that may be in their nature disputed) is referred to a committee of members who examine the matter alleged, and accordingly report it to the House; and then (or, otherwise, upon the mere petition) leave is given to bring in the bill. In public matters, the bill is brought in upon motion made to the House, without any petition at all. The persons directed to bring in the bill present it in a competent time to the House, drawn out on paper, with a multitude of blanks or void spaces, where any thing occurs that is dubious, or necessary to be settled by the Parliament itself, (such, especially, as the precise date of times, the nature and quantity of penalties, or of any sums of money to be raised,) being, indeed, only the skeleton of the bill. In the House of Lords, if the bill begins there, it is (when of a private nature) referred to two of the judges who examine and report the state of the facts alleged, to see that all necessary parties consent, and to settle all points of technical propriety. This is read a first time, and, at a convenient distance, a second time; and, after each reading, the Speaker opens to the House the substance of the bill, and puts the question, whether it shall proceed any farther? The introduction of the bill may be originally opposed, as the bill itself may, at either of the readings; and if the opposition succeeds, the bill must be dropped for that session; as it must also, if opposed with success, in any of the subsequent stages. After the second reading, it is committed; that is, referred to a committee: which is either selected by the House, in matters of small importance, or else, upon a bill of consequence, the House resolves itself into a committee of the whole House. A committee of the whole House is composed of every member; and, to form it, the Speaker quits the chair, (another member being appointed chairman,) and may sit and debate as a private member. In these committees, the bill is debated, clause by clause, amendments made, the blanks filled up, and sometimes the bill entirely new modelled. After it has gone through the committee, the chairman reports it to the House, with such amendments as the committee have made; and then the House considers the whole bill again, and the question is repeatedly put upon every clause and amendment. When the House has agreed, or disagreed to the amendments of the committee, and sometimes added new amendments of its own, the bill is then ordered to be engrossed, or written in a strong gross hand on one or more long rolls (or presses) of parchment, sewed together. When this is finished, it is read a third time, and amendments are sometimes then made to it; and if a new clause be added, it is done by tacking a separate piece of parchment on the bill, which is called a ryder. The Speaker then again opens the contents; and, in holding it up in his hands puts the question, whether the bill shall pass? If this is agreed to, the title to it is then settled; which used to be a general one for all the acts passed in the session, till in the fifth year of Henry VIII. distinct titles were introduced for each chapter. After this, one of the members is directed to carry it to the Lords, and desire their concurrence; who, attended by several more, carries it to the bar of the House of Peers, and there delivers it to their Speaker, who comes down from the woolsack to receive it. It there passes through the same forms as in the other House (except engrossing, which is already done): and, if rejected, no more notice is taken, but it passes *sub silentio*, to prevent unbecoming altercations; but if it is agreed to, the Lords send a message by two masters in chancery, (or sometimes two of the judges,) that they have agreed to the same, and the bill remains with the Lords, if they have made no amendments to it; but if any amendments are made, such amendments are sent down with the bill, to receive the concurrence of the Commons. If the Commons disagree to the amendments, a conference usually follows between members deputed from each House; who, for the most part, settle and adjust the difference; but if both Houses remain inflexible, the bill is dropped. If the Commons agree to the amendments, the bill is sent back to the Lords by one of the members, with a message to acquaint them therewith. The same forms are observed, *mutatis mutandis*, when the bill begins in the House of

Lords. But when an act of grace, or pardon, is passed, it is first signed by his Majesty, and then read once only in each of the Houses, without any new engrossing or amendment. And when both Houses have done with any bill, it always is deposited in the House of Peers, to wait the royal assent; except in the case of a bill of supply, which after receiving the concurrence of the Lords is sent back to the House of Commons. The royal assent may be given two ways: 1. In person; when the King comes to the House of Peers, in his crown and royal robes, and sending for the Commons to the bar, the titles of all the bills that have passed both Houses are read, and the King's answer is declared by the clerk of the parliament in Norman French: a badge, it must be owned (now the only one remaining) of conquest; and which one could wish to see fall into total oblivion; unless it be reserved as a solemn memento to remind us that our liberties are mortal, having been once destroyed by a foreign force. If the King consents to a public bill, the clerk usually declares, "Le roy le veut." "The King wills it so to be;" if to a private bill, "Soit fait comme il est desire;" "Be it as it is desired." If the King refuses his assent, it is in the gentle language of "Le roy s'avisera:" "The King will advise upon it." When a bill of supply is passed, it is carried up and presented to the King by the Speaker of the House of Commons, and the royal assent is thus expressed; "Le roy remercie ses loyal subjects, accepte leur benevolence, et aussi le voit;" "The King thanks his loyal subjects, accepts their benevolence, and wills it so to be." In case of an act of grace, which originally proceeds from the crown, and has the royal assent in the first stage of it, the clerk of the parliament thus pronounces the gratitude of the subject: "Les Prelats, Seigneurs, et Commons, en ce present parliament assemblees, au nom de touts vous autres subjects, remercient tres humblement votre Majeste, et prient a Dieu vous donner en sante bone vie et longue;" "The Prelates, Lords, and Commons, in this present parliament assembled, in the name of all your other subjects, most humbly thank your Majesty, and pray to God to grant you in health long to live."

2. By the stat. 33 Hen. III. c. 21, the King may give his assent by letters patent under his great seal, signed with his hand, and notified in his absence to both Houses assembled together in the High House. And when the bill has received the royal assent in either of these ways, it is then, and not before, a statute or act of parliament. This statute or act is placed among the records of the kingdom; there needing no formal promulgation to give it the force of a law, as was necessary by the civil law with regard to the emperor's edicts; because every man in Britain is, in judgment of law, party to the making of an edict of parliament, being present thereat by his representatives. However, a copy thereof is usually printed at the King's press, for the information of the whole land. And formerly, before the invention of printing, it was used to be published by the sheriff of every county: the King's writ being sent to him at the end of every session, together with a transcript of all the acts made at that session, commanding him, "ut statuta illa, et omnes articulos in eisdem contentos, in singulis locis ubi expedire viderit, publice proclamari, et firmiter teneri et observari faciat." And the usage was, to proclaim them at his county court, and there to keep them, that whoever would might read or take copies thereof; which custom continued till the reign of Henry VII. An act of parliament thus made is the exercise of the highest authority that this kingdom acknowledges upon earth. It hath power to bind every subject in the land, and the dominions thereunto belonging; nay, even the King himself, if particularly named therein. And it cannot be altered, amended, dispensed with, suspended, or repealed, but in the same forms, and by the same authority of parliament: for it is a maxim in law, that it requires the same strength to dissolve as to create an obligation. It is true, it was formerly held that the King might in many cases dispense with penal statutes; but now, by statute 1 Wil. and M. st. 2, c. 2, it is declared, that the suspending or dispensing with laws by regal authority, without consent of parliament, is illegal. See Acts.

BILLARDIERA, in botany, a genus of the Pentandria Monogynia class and order. Petals five, alternating with the leaflets of the calyx; stigma simple; no nectary; berries superior; many-seeded. One species, found at New-Holland.

BILLET, in heraldry, a bearing in form of a long square. They are supposed to represent pieces of cloth of gold or silver, but Guilim thinks they represent a letter sealed up; and other authors take them for bricks.

Billet *wood*, small wood for fuel, cut three feet and four inches long, and seven inches and a half in compass; the assize of which is to be enquired of by justices.

BILLETTING, in military affairs, is the quartering of soldiers in the houses of a town or village.

BILLIARDS, an ingenious kind of game, played on a rectangular table, with little ivory balls, which are driven into hazards or holes, according to certain rules of the game. The table on which the game is played is generally about twelve feet long and six feet wide, or rather in the exact form of an oblong; it is covered with fine green cloth, and surrounded with cushions, to prevent the balls rolling off, and to make them rebound. There are six holes, nets, or pockets: these are fixed at the four corners, and in the middle opposite to each other, to receive the balls, which, when put into these holes or pockets, are called hazards. The making of a hazard, that is, putting the adversary's ball in, at the usual game, reckons for two in favour of the player. The game is played with sticks called maces, or with cues; the first consists of a long straight stick, with a head at the end, and are the most powerful instruments of the two: the cue is a thick stick, diminishing gradually to a point of about half an inch diameter; this instrument is played over the left hand, and supported by the fore-finger and thumb. It is the only instrument in vogue abroad, and is played with amazing address by the Italians and some of the Dutch; but in England the mace is the prevailing instrument, which the foreigners hold in contempt, as it requires not near so much address to play the game with, as when the cue is made use of; but the mace is preferred for its peculiar advantage, which some professed players have artfully introduced, under the name of trailing, that is, following the ball with the mace to such a convenient distance from the other ball as to make it an easy hazard. The degrees of trailing are various, and undergo different denominations amongst the connoisseurs at this game; *viz.* the shove, the sweep, the long stroke, the trail, and the dead trail, or turn up, all which secure an advantage to a good player, according to their various gradations: even the butt end of the cue becomes very powerful, when it is made use of by a good trailer.

Rules generally observed at the common or usual game:—1. For the lead, the balls must be put at one end, and the player must strike them against the farthermost cushion, in order to see which will be nearest the cushion that is next to them. 2. The nearest to the cushion is to lead, and choose the ball, if he pleases. 3. The leader is to place his ball at the nail, and not to pass the middle pocket; and if he holes himself in leading, he loses the lead. 4. He who follows the leader must stand within the corner of the table, and not place his ball beyond the nail. 5. He who plays upon the running ball loses one. 6. He who touches the ball twice, and moves it, loses one. But these two rules are seldom or never enforced, especially in England. 7. He who does not hit his adversary's ball loses one. 8. He who touches both balls at the same time, makes a foul stroke, in which case, if he should hole his adversary, nothing is gained by the stroke; but if he should put himself in, he loses two. 9. He who holes both balls loses two. 10. He who strikes upon his adversary's ball and holes himself loses two. 11. He who plays at the ball without striking it and holes himself loses three. 12. He who strikes both balls over the table loses two. 13. He who strikes his ball over the table, and does not hit his adversary's ball, loses three. 14. He who retains the end of his adversary's stick when playing, or endeavours to baulk his stroke, loses one. 15. He who plays another's ball or stroke without leave loses one. 16. He who takes up his ball, or his adversary's, without leave, loses one. 17. He who stops either ball when running loses one; and being near the hole loses two. 18. He who blows upon the ball when running loses one, and if near the hole loses two. 19. He who shakes the table when the ball is running loses one. 20. He who strikes the table with the stick, or plays before his turn, loses one. 21. He who throws the stick upon the table and hits the ball loses one. 22. If the ball stand upon the edge of the hole, and after being challenged it fall in, it is nothing, but must be put up where it was before. 23. If any person, not being one of the players, stops a ball, the ball must stand in the place where it was stopped. 24. He who plays without a foot upon the floor, and holes his adversary's ball, gets nothing for it, but loses the lead. 25. He who leaves the game before it is ended loses it. 26. Any person may change his stick in play. 27. If any difference arises between players, he who marks the game, or the majority of the company, must decide it. 28. Those who do not play must stand from the table, and make room for the players. 29. If any person lays any wager, and does not play, he shall not give advice to the players upon the game.

Different kinds of games played at billiards.—Besides the common winning game, which is twelve up, there are several other kinds of game, *viz.* the losing game, the winning and losing, choice of balls, bricole, carambole, Russian carambole, the barhole, the one-hole, the four-game, and hazards: but on these it is not necessary to enlarge.

BINARY *arithmetic*, that wherein unity, or 1 and 0, are only used. This was the invention of Mr. Liebnitz, who shews it to be very expeditious in discovering the properties of numbers, and in constructing tables; and Mr. Dangecourt, in the "History of the Royal Academy of Sciences," gives a specimen of it concerning arithmetical progressionals; where he shews that, because in binary arithmetic only two characters are used, therefore the laws of progression may be more easily discovered by it than by common arithmetic. All the characters used in binary arithmetic are 0 and 1, and the cypher multiplies every thing by 2, as in the common arithmetic by 10. Thus, 1 is one; 10, two; 11, three; 100, four; 101, five; 110, six; 111, seven; 1000, eight; 1001, nine; 1010, ten; which is built on the same principles with common arithmetic. The author, however, does not recommend this method for common use, because of the great number of figures required to express a number; and adds, that if the common progression were from 12 to 12, or from 16 to 16, it would be still more expeditious.

BIND *weed.* See CONVOLVULUS.

BINOMIAL, in algebra, a root consisting of two members, connected by the sign + or —. Thus $a+b$ and $8-3$ are binomials, consisting of the sums and differences of these quantities.

The powers of any binomial are found by a continual multiplication of it by itself. For example, the cube or third power of $a+b$, will be found by multiplication to be $a^3+3a^2b+3ab^2+b^3$; and if the powers of $a-b$ are required, they will be found the same as the preceding, only the terms in which the exponent of b is an odd number will be found negative. Thus, the cube of $a-b$ will be found to be $a^3-3a^2b+3ab^2-b^3$, where the second and fourth terms are negative, the exponent of b being an odd number in these terms. In general, the terms of any power of $a-b$ are positive and negative by turns.

It is to be observed, that in the first term of any power of $a+b$, the quantity a has the exponent of the power required, that in the following terms the exponents of a decrease gradually by the same differences, *viz.* unit, and that in the last terms it is never found. The powers of b are in the contrary order; it is never found in the first term, but its exponent in the second term is unit; in the third term its exponent is 2; and thus its exponent increases, till in the last term it becomes equal to the exponent of the power required.

As the exponents of a thus decrease, and at the same time those of b increase, the sum of their exponents is always the same, and is equal to the exponent of the power required. Thus, in the sixth power of $a+b$; *viz.* $a^6+6a^5b+15a^4b^2+20a^3b^3+15a^2b^4+6ab^6+b^5$, the exponents of a decrease in this order 6, 5, 4, 3, 2, 1, 0; and those of b increase in the contrary order 0, 1, 2, 3, 4, 5, 6. And the sum of their exponents in any term is always 6.

In general, therefore, if $a+b$ is to be raised to any power m, the terms without their coefficients will be a^m, $a^{m-1}b$, $a^{m-1}b^2$; $a^{m-3}b^3$, $a^{m-4}b^4$, $a^{m-5}b^5$, &c. continued till the exponent of b become equal to m.

The coefficients of the respective terms will be 1; m; $m \times \frac{m-1}{2}$; $m \times \frac{m-1}{2} \times \frac{m-2}{3}$; $m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4}$; $m \times \frac{m-1}{2} \times \frac{-2}{3} \times \frac{m-3}{4} \times \frac{m-4}{5}$, &c. continued until you have one coefficient more than there are units in m.

It follows therefore by these rules, that $\overline{a+b}^m = a^m + m a^{m-1} b + m + \frac{m-1}{2} + a^{m-2}b^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times a^{m-3} b^3 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times a^{m-4}b^4 +$, &c. which is the binomial or general theorem for raising a quantity consisting of two terms to any power m.

The same general theorem will also serve for the evolution of binomials, because to extract any root of a given quantity is the same thing as to raise that quantity to a power, whose exponent is a fraction that has its denominator equal to the number that expresses what kind of root is to be extracted. Thus, to extract the square root of $a+b$, is to raise $a+b$ to a power whose exponent is $\frac{1}{2}$. Now, $\overline{a+b}^m$ being found as above; supposing $m=\frac{1}{2}$, you will find $\overline{a+b}^{\frac{1}{2}} = a^{\frac{1}{2}} + \frac{1}{2} \times a^{-\frac{1}{2}} b + \frac{1}{2} \times -\frac{1}{4} \times a^{-\frac{3}{2}} b^2 + \frac{1}{2} \times$

$-\frac{1}{4} \times -\frac{1}{2} a - \frac{1}{2} b^3 +$, &c. $= a^{\frac{1}{2}} + \frac{b}{2a^{\frac{1}{2}}} - \frac{b^2}{8a^{\frac{3}{2}}} + \frac{b^3}{16a^{\frac{5}{2}}}, -$, &c.

To investigate this theorem, suppose n quantities, $x + a$, $x + b$, $x + c$, &c. multiplied together; it is manifest that the first term of the product will be x^n, and that x^{n-1}, x^{n-2}, &c. the other powers of x, will all be found in the remaining terms, with different combinations of a, b, c, d, &c.

Let $\overline{x+b} . \overline{x+c} . \overline{x+d}$. &c. $= x^{n-1} + Px^{n-2} + Qx^{n-3} +$ &c. and $\overline{x+a} . \overline{x+b} . \overline{x+c} . \overline{x+d}$. &c. $= x^n + Ax^{n-1} + Bx^{n-2} +$ &c. then $\overline{x^n + Ax^{n-1} + Bx^{n-2} + \text{\&c.}}$ and $\overline{x+x \times x^{n-1} + Px^{n-2} + Qx^{n-3} + \text{\&c.}}$ or,

$$\left.\begin{matrix} x^n + Px^{n-1} + Qx^{n-2} + \text{\&c.} \\ + ax^{n-1} + aPx^{n-2} + \text{\&c.} \end{matrix}\right\} \text{are the same series;}$$

therefore, $A = P + a$, $B = Q + aP$, &c. that is, by introducing one factor, $x+a$, into the product, the coefficient of the second term is increased by a, and by introducing $x+b$ into the product, that coefficient is increased by b, &c. therefore the whole value of A is $a + b + c + d +$ &c. Again, by the introduction of one factor, $x+a$, the coefficient of the third term, Q, is increased by a P, *i. e.* by a multiplied by the preceding value of A, or by $a \times \overline{b+c+d+\text{\&c.}}$ and the same may be said with respect to the introduction of every other factor; therefore, upon the whole,

$$\begin{aligned} B = & \; a . \overline{b+c+d+\text{\&c.}} \\ & + b . \overline{c+d+\text{\&c.}} \\ & + c . \overline{d+\text{\&c.}} \end{aligned}$$

In the same manner,

$$\begin{aligned} C = & \; a . b . \overline{c+d+\text{\&c.}} \\ & + a . c . \overline{d+\text{\&c.}} \\ & + b . c . \overline{d+\text{\&c.}} \end{aligned}$$

and so on; that is, A is the sum of the quantities a, b, c, &c. B is the sum of the products of every two; C is the sum of the products of every three, &c. &c.

Let $a = b = c = d =$ &c. then A, or $a + b + c + d +$ &c. $= na$; $= ab + ac$ B $+ bc +$ &c. $= a^2 \times$ the number of combinations of a, b, c, d, &c. taken two and two, $= n . \frac{n-1}{2} a^2$; in the same manner it appears that $C = n . \frac{n-1}{2} \frac{n-2}{3} a^3$, &c.

And $\overline{x+a} . \overline{x+b} . \overline{x+c}$. &c. to n factors $= \overline{x+a}|$; therefore $\overline{x+a}|^n = x^n + n a x^{n-1} + n . \frac{n-1}{2} a^2 x^{n-2} + n . \frac{n-1}{2} . \frac{n-2}{3} a^3 x^{n-3} +$ &c.

This proof applies only to those cases in which n is a whole positive number; but the rule extends to those cases in which n is negative or fractional.

Ex. 1. $\overline{a+x}|^8 = a^2 + 8a^7x + 28a^6x^2 + 56a^5x^3 + 70a^4x^4 + 56a^3x^5 + 28a^2x^6 + 8ax^7 + x^8$.

Ex. 2. $\overline{1+x}|^n = 1 + nx + n . \frac{n-1}{2} x^2 + n . \frac{n-1}{2} . \frac{n-2}{3} x^3 +$ &c.

Ex. 3. $\overline{a^2+x^2}|^n = a^2 + n a^{2n-2} x^2 + n . \frac{n-1}{2} a^{2n-4} x^4 +$ &c.

If either term of the binomial be negative, its odd powers will be negative, and consequently the signs of the terms, in which those odd powers are found, will be changed.

Ex. 4. $\overline{a-x}|^8 = a^8 - 8a^7x + 28a^6x^2 - 56a^5x^3 + 70a^4x^4 - 56a^3x^5 + 28a^2x^6 - 8ax^7 + x^8$.

Ex. 5. $\overline{a^2-x^2}|^n = a^{2n} - n a^{2n-2} x^2 + n . \frac{n-1}{2} a^{2n-4} x^4 -$ &c.

If the index of the power to which a binomial is to be raised be a whole positive number, the series will terminate, because the co-efficient $n . \frac{n-1}{2} . \frac{n-2}{3}$. &c. will become nothing when it is continued to $n+1$ factors. In all other cases the number of terms will be indefinite.

When the index is a whole positive number, the co-efficients of the terms taken backward, from the end of the series, are respectively equal to the co-efficients of the corresponding terms taken forward from the beginning.

Thus, in the first example, where $a+x$ is raised to the 8th power, the co-efficients are, 1, 8, 28, 56, 70, 56, 28, 8, 1.

In general, the coefficient of the $\overline{n+1}$th term is $\frac{n . \overline{n-1} . \overline{n-2} \ldots . 3 . 2 . 1}{1 . 2 . 3 . \ldots . \overline{n-2} . \overline{n-1} . n} = 1$

The co-efficient of the nth term is $\frac{n . \overline{n-1} . \overline{n-2} \ldots 3 . 2 .}{1 . 2 . 3 \ldots . \overline{n-2} . \overline{n-1}} = n$; of the $\overline{n-1}$th term, $\frac{n . \overline{n-1} . \overline{n-2} \ldots 3 .}{1 . 2 . 3 . \ldots . \overline{n-2}} = \frac{n . \overline{n-1}}{1 . 2}$, &c.

The sum of the co-efficients $1+n+n.\frac{n-1}{2}+$ &c. is 2^n.

For if $x=a=1$, then $\overline{x+a}|^n=\overline{1+1}|^n=2^n=1+n+n.\frac{n-1}{2}+$ &c.

Since $\overline{x+a}|^n=x^n+n\,a\,x^{n-1}+n.\frac{n-1}{2}a^2\,x^{n-2}+$ &c.

And $\overline{x-a}|^n=x^n-n\,a\,x^{n-1}+n.\frac{n-1}{2}a^2\,x^{n-2}-$ &c.

By addition, $\overline{x+a}|^n+\overline{x-a}|^n=2.x^n+2.n.\frac{n-1}{2}a^2\,x^{n-2}+$ &c.

Or $\frac{\overline{x+a}|^n+\overline{x-a}|^n}{2}=x^n+n.\frac{n-1}{2}a^2\,x^{n-2}+$ &c.

By subtracting one series from the other, $\frac{\overline{x+a}|^n-\overline{x-a}|^n}{2}=n\,a\,x^{n-1}+n.\frac{n-1}{2}\frac{n-2}{3}a^3\,x^{n-3}+$ &c.

The trinominal $a+b+c$ may be raised to any power by considering two terms as one factor, and proceeding as before.

Thus, $a+\overline{b+c}|^n=a^n+n.\overline{b+c}.a^{n-1}+n.\frac{n-1}{2}.\overline{b+c}|^2.a^{n-2}+$ &c. and the powers of $b+c$ may be determined by the binomial theorem.

BIOGRAPHY, a very entertaining and instructive species of history, containing the life of some remarkable person or persons.

Lord Bacon regrets, that the lives of eminent men are not more frequently written: for, adds he, though kings, princes, and great personages, be few; yet there are many other excellent men, who deserve better than vague reports and barren elogies.

Biography, or the art of describing and writing lives, is a branch or species of history, in many respects as useful and important as that of history itself; inasmuch as it represents great men more distinctly, unencumbered with associates: and descending into the detail of their actions and characters, their virtues and failings, we obtain a more particular, and, of course, a more interesting acquaintance with individuals, than general history allows. A writer of lives may, and ought, to descend to minute circumstances and familiar incidents. He is expected to give the private, as well as the public, life of those whose actions he records; and it is from private life, from familiar, domestic, and apparently trivial occurrences, that we often derive the most accurate knowledge of the real character.

The subjects of Biography are not only the lives of public or private persons, who have been eminent and beneficial to the world, but those also of persons notorious for their vice and profligacy, which may serve, when justly characterised, as warnings to others, by exhibiting the fatal consequences, which, sooner or later, generally follow licentious practices. As for those who have exposed their lives, or devoted their time and talents for the service of their fellow-creatures, it is but a debt of gratitude to perpetuate their memories, by making posterity acquainted with their merits and usefulness. In the lives of public persons, their public characters are principally, but not solely, to be regarded; the world is interested in the minutest actions of great men, and their examples, both as public and private characters, may be made subservient to the well-being and prosperity of society.

It has been a matter of dispute among the learned, whether any one ought to write his own history. There are instances, both ancient and modern, that may be adduced as precedents for the practice: and the reason assigned for it is, that no man can be so much the master of the subject as the person himself: but, on the other hand, it is a very difficult task for any one to write an impartial history of his own actions. Plutarch mentions two cases, in which it is allowable for a man to commend himself, and to be the publisher of his own merits; which are, when the doing of it may be of considerable advantage either to himself or to others. Notwithstanding this high authority, the former case is unquestionably liable to great objections, because a man is to be the judge in his own cause, and therefore very liable to exceed the limits of truth, when his own interests are concerned, and when he wishes to render himself conspicuous for virtue or talents. The ancients, however, had a peculiar method of diverting the reader's attention from themselves, when they had occasion to record their own actions, and of thus rendering what they said less invidious, which was, by speaking of themselves in the third person. Among the moderns a practice has been introduced, which cannot be too strongly reprobated, though sanctioned by men of great talent, integrity, and real worth;

namely, of making the memoirs of themselves the vehicle of abuse of their contemporaries, every one of whom would, no doubt, be able to give a very different, and perhaps plausible reason, for the several actions which the biographer has undertaken to scrutinize and condemn.

Dr. Priestley has constructed and published a "Biographical Chart," of which our plate is given as a specimen. This chart represents the interval of time between the year 1200 before the Christian æra, and 1800 after Christ, divided by an equal scale into centuries. It contains about 2000 names of persons, the most distinguished in the annals of fame, the length of whose lives is represented by lines drawn in proportion to their real duration, and terminated in such a manner as to correspond to the dates of their births and deaths. These names are distinguished into several classes by parallel lines running the whole length of the chart, the contents of each division being expressed at the end of it. The chronology is noted in the margin, on the upper side, by the year before and after Christ, and on the lower by the same æra, and also by the succession of such kings as were most distinguished in the whole period. See Plate BIOGRAPHY.

For a more full account we refer to Dr. Priestley's description, which accompanies the chart; from which we shall make a short extract, that cannot fail to entertain the reader.

"Laborious and tedious as the compilation of this work has been (vastly more so than my first conceptions represented it to me), a variety of views were continually opening upon me during the execution of it, which made me less attentive to the labour. As these views agreeably amuse the mind, and may, in some measure, be enjoyed by a person who only peruses the chart, without the labour of compilation, I shall mention a few of them in this place.

"It is a peculiar kind of pleasure we receive, from such a view as this chart exhibits of a great man, such as Sir Isaac Newton, seated, as it were, in the circle of his friends and illustrious contemporaries. We see at once with whom he was capable of holding conversation, and in a manner (from the distinct view of their respective ages) upon what terms they might converse. And though it be melancholy, it is not unpleasing, to observe the order in which we here see illustrious persons go off the stage, and to imagine to ourselves the reflections they might make upon the successive departure of their acquaintance or rivals.

"We likewise see, in some measure, by the names which precede any person, what advantages he enjoyed from the labours and discoveries of others; and, by those which follow him, of what use his labours were to his successors.

"By the several void spaces between such groups of great men, we have a clear idea of the great revolutions of all kinds of science, from the very origin of it; so that the thin and void places in the chart are, in fact, no less instructive than the most crowded, in giving us an idea of the great interruptions of science, and the intervals at which it hath flourished. The state of all the divisions appropriated to men of learning is, for many centuries before the revival of letters in this western part of the world, exactly expressed by this following line of Virgil:

Apparent rari nantes in gurgite vasto.

But we see no void spaces in the division of statesmen, heroes, and politicians. The world hath never wanted competitors for empire and power, and least of all in those periods in which the sciences and the arts have been the most neglected.

"But the noblest prospect of this nature is suggested by a view of the crowds of names, in the divisions appropriated to the arts and sciences in the two last centuries. Here all the classes of renown, and, I may add, of merit, are full; and a hundred times as many might have been admitted, of equal attainments in knowledge with their predecessors. This prospect gives us a kind of security for the continual propagation and extension of knowledge; and that, for the future, no more great chasms of men, really eminent for knowledge, will ever disfigure that part of the chart of their lives which I cannot draw, or ever see drawn. What a figure must science make, advancing as it now does, at the end of as many centuries as have elapsed since the Augustan age!"

BIPED, in zoology, an animal furnished with only two legs. Men and birds are bipeds. Apes occasionally walk on their hind legs, and seem to be of this tribe; but that is not a natural position for them, and they rest upon all their legs, like other quadrupeds. The jerboas are also of the latter description, jumping and leaping on their hind legs, but resting on their fore legs likewise.

BIQUADRATIC *power*, in algebra, the fourth power or squared square of a number, as 16 is the biquadratic power of

2; for 2 × 2 is 4, and 4 × 4 is equal to 16.

Biquadratic *root of a number*, is the square root of its square root: thus the biquadratic root of 81 is 3; for the square root of 81 is 9, and the square root of 9 is 3.

Biquadratic *equation*, an equation where the unknown quantity of one of the terms has four dimensions.

Any biquadratic equation may be conceived as generated by the multiplication of four simple equations. Thus, if $x=a$ $x=b$, $x=c$, $x=d$, or $x-a=0$, $x-b=0$, $x-c=0$, $x-d=0$; then will $x-a\times x-b\times x-c\times x-d=0$, beget a biquadratic equation. Or it may be formed of two quadratic equations, as $\overline{x^2+bx+c}\times\overline{x^2+dx+e}=0$; or, lastly, it may be produced from the multiplication of one cubic and one simple equation, as $\overline{x-a}\times\overline{x^3+cx^2+dx+e}=0$. For an account of the resolution of biquadratic equations, see Equations.

BIQUINTILE, an aspect of the planets, when they are 144 degrees from each other.

BIRCH *tree*. See Betula.

BIRD, in zoology. See Aves.

Bird-*catching*, the art of taking birds or wild fowl, whether for food, for the pleasure of their song, or for their destruction, as pernicious to the husbandman, &c. The methods are by bird-lime, nets, decoys, &c. In the suburbs of London are several weavers and other tradesmen, who, during the months of October and March, get their livelihood by an ingenious, and, we may say, a scientific method of bird-catching, which is totally unknown in other parts of Great Britain. The reason of this trade being confined to so small a compass arises from there being no considerable sale of singing birds, except in the metropolis: as the apparatus for this purpose is also heavy, and at the same time must be carried on a man's back, it prevents the bird-catchers going to more than three or four miles distance.

This method of bird-catching must have been long practised, as it is brought to a most systematical perfection, and is attended with a very considerable expense. The nets are a most ingenious piece of mechanism; they are generally twelve yards and a half long, and two yards and a half wide; and no one, on bare inspection, would imagine that a bird, who is so very quick in all its motions, could be catched by the nets flapping over each other, till he becomes an eye-witness of the pullers seldom failing. The wild birds fly, as the bird-catchers term it, chiefly during the month of October, and part of September and November, as the flight in March is much less considerable than that of Michaelmas. It is to be noted, also, that the several species of birds of flight do not make their appearance precisely at the same time, during the months of September, October, and November. The pippet, a small species of lark, for example, begins to fly about Michaelmas; and then the woodlark, linnet, goldfinch, chaffinch, greenfinch, and other birds of flight, succeed, all of which are not easily to be caught, or in any numbers at any other time, and more particularly the pippet and the woodlark. These birds, during the Michaelmas and March flights, are chiefly on the wing from day-break to noon, though there is afterwards a small flight from two till night; but this, however, is so inconsiderable, that the bird-catchers always take up their nets at noon. The bird-catcher generally carries with him five or six linnets, of which more are caught than any singing bird, two goldfinches, two greenfinches, one woodlark, one redpoll, yellowhammer, titlark, and aberdevine, and perhaps a bullfinch; these are placed at small distances from the nets, in little cages. He has besides what are called flur-birds, which are placed within the nets, are raised upon the flur, or moveable perch, and gently let down at the time the wild bird approaches them. These generally consist of the linnet, the goldfinch, and the greenfinch, which are secured to the flur by what is called a brace or bandage, a contrivance which secures the birds without doing any injury to their plumage. When the bird catcher has laid his nets, he disposes of his call birds at proper intervals. It must be owned that there is most malicious joy in these call-birds, to bring the wild ones into the same state of captivity; which may likewise be observed with regard to the decoy ducks. See Decoy.

Their sight and hearing infinitely excel that of the bird catcher. The instant that the wild birds are perceived, notice is given by one to the rest of the call-birds, (as it is by the first hound that hits on the scent to the rest of the pack) after which follows the same sort of tumultuous extacy and joy. The call-birds, while the bird is at a distance, do not sing as a bird does in a chamber; they invite the wild ones by what the bird-catchers call short jerks, which, when the birds are good, may be heard at a great distance. The ascendency by this call or invitation is so great, that the wild bird is stopped in its course of flight; and, if not already acquainted with the nets, lights boldly within 20 yards of perhaps three or four bird-catchers, on a spot which otherwise it would not have taken the least notice of. Nay, it frequently happens, that if half a flock only are caught, the remaining half will immediately afterwards light in the nets, and share the same fate; and should only one bird escape, that bird will suffer itself to be pulled at till it is caught; such a fascinating power have the call-birds.

The nightingale is not a bird of flight, in the sense the bird-catchers use this term. Like the robin, wren, and many other singing birds, it only moves from hedge to hedge, and does not take the periodical flights in October and March.

The persons who catch these birds make use of small trap-nets, without call-birds; and are considered as inferior in dignity to other bird-catchers, who will not rank with them. The arrival of the nightingale is expected by the trappers in the neighbourhood of London the first week in April: at the beginning, none but cocks are taken; but in a few days the hens make their appearance, generally by themselves, though sometimes a few males come along with them. The latter are distinguished from the females, not only by their superior size, but by a great swelling of their vent, which commences on the first arrival of the hens. They are caught in a net-trap, the bottom of which is surrounded with an iron ring; the net itself is rather larger than a cabbage-net. When the trappers hear or see them, they strew some fresh mould under the place, and bait the trap with a meal-worm from the baker's shop. Ten or a dozen nightingales have been thus caught in a day.

The common way of taking larks, of which so many are used at our tables, is in the night, with those nets which are called trammels. These are usually made of 36 yards in length, and about six yards over, with six ribs of packthread, which at the ends are put upon two poles of about 16 feet long, and made lesser at each end. These are to be drawn over the ground by two men, and every five or six steps the net is made to touch the ground, otherwise it will pass over the birds, without touching them, and they will escape. When they are felt to fly up against the net, it is clapped down, and then all are safe that are under it. The darkest nights are properest for this sport; and the net will not only take larks, but all other birds that roost on the ground, among which are woodcocks, snipes, partridges, quails, fieldfares, and several others.

In the depth of winter, people sometimes take great numbers of larks by nooses of horse hair. The method is this: take 100 or 200 yards of packthread; fasten at every six inches a noose made of double horse hair; at every 20 yards the line is to be pegged down to the ground, and so left ready to take them. The time to use this is when the ground is covered with snow, and the larks are to be allured to it by some white oats scattered all the way among the nooses. They must be taken away as soon as three or four are hung, otherwise the rest will be frighted; but though the others are scared away just where the sportsman comes, they will be feeding at the other end of the line, and the sport may be thus continued for a long time.

Those caught in the day are taken in clap-nets of 15 yards length, and two and a half in breadth, and are enticed within the reach by bits of looking-glass, fixed in a piece of wood, and placed in the middle of the nets, which are put in a quick whirling motion by a string the larker commands; he also makes use of a decoy lark. These nets are used only till the 14th of November; for the larks will not dare, or frolic in the air, except in fine sunny weather; and, of course, cannot be inveigled into the snare. When the weather grows gloomy, the larker changes his engine, and makes use of a trammel-net, twenty-seven or twenty-eight feet long, and five broad; which is put on two poles, eighteen feet long, and carried by men under each arm, who pass over the fields, and quarter the ground as a setting dog: when they hear or feel a lark hit the net, they drop it down, and so the birds are taken.

But the most singular species of bird-catching is on the Holm of Ness, a vast rock severed from the isle of Ness by some unknown convulsion, and only about sixteen fathoms distance. It is of the same stupendous height as the opposite precipice, with a raging sea between; so that the intervening chasm is of matchless horror. Some adventurous climber reaches the rock in a boat, gains the height, and fastens several stakes on the small portion of earth which is to be found on the top; correspondent stakes are placed on the edge of the correspondent cliffs: a rope is fixed to the stakes on both sides, along which a machine, called a cradle is contrived to slide; and, by the help of a small parallel cord, fastened in like manner, the adventurer wafts himself over, and returns with his booty.

The manner of bird-catching, in the Feroe islands, is very strange and hazardous. Necessity compels mankind to wonderful attempts. The cliffs which contain the objects of their search are often two hundred fathoms in height, and are attempted from above and below. In the first case, the fowlers provide themselves with a rope eighty or one hundred fathoms in length. The fowler fastens one end about his waist and between his legs, recommends himself to the protection of the Almighty, and is lowered down by six others, who place a piece of timber on the margin of the rock, to preserve the rope from wearing against the sharp edge. They have besides a small line fastened to the body of the adventurer, by which he gives signals that they may lower or raise him, or shift him from place to place. The last operation is attended with great danger, by the loosening of the stones, which often fall on his head, and would infallibly destroy him, was he not protected by a strong thick cap; but even that is found unequal to save him against the weight of the larger fragments of rock. The dexterity of the fowlers is amazing; they will place their feet against the front of the precipice, and dart themselves some fathoms from it, with a cool eye survey the places where the birds nestle, and again shoot into their haunts. In some places the birds lodge in deep recesses: the fowler will alight there, disengage himself from the rope, fix it to a stone, and at his leisure collect the booty, fasten it to his girdle, and resume his pendulous seat. At times he will again spring from the rock, and in that attitude, with a fowling net placed at the end of a staff, catch the old birds which are flying to and from their retreats. When he has finished his dreadful employment, he gives a signal to his friends above, who pull him up, and share the hard-earned profit. The feathers are preserved for exportation; the flesh is partly eaten fresh; but the greater portion dried for winter's provision.

The fowling from below has its share of danger. The party goes on the expedition in a boat; and when it has attained the base of the precipice, one of the most daring, having fastened a rope about his waist, and furnished himself with a long pole with an iron hook at one end, either climbs, or is thrust up by his companions, who place a pole under his breech, to the next footing spot he can reach. He, by means of the rope, brings up one of the boat's crew; the rest are drawn up in the same manner, and each is furnished with his rope and fowling-staff. They continue their progress upwards, in the same manner, till they arrive at the region of birds; and wander about the face of the cliff in search of them. They then act in pairs; one fastens himself to the end of his associate's rope, and in places where birds have nestled beneath his footing, he permits himself to be lowered down, depending for his security on the strength of his companion, who has to haul him up again; but it sometimes happens, that the person above is overpowered by the weight, and both inevitably perish. They fling the fowl into the boat, which attends their motions, and receives the booty. They often pass seven or eight days in this tremendous employment, and lodge in the crannies which they find in the face of the precipice.

Birds are likewise caught in traps of various kinds; and frequently by nooses of hairs. In this way great numbers of wheat-ears are annually taken on the various downs of England, particularly in Sussex. Small holes are dug by the shepherds in the ground, in each of which is placed a noose. Whenever a cloud obscures the sun, these timid birds seek for shelter under a stone, or creep into any holes that present themselves: and they are thus ensnared by the nooses, which fasten around their necks. Woodcocks and snipes are taken likewise by nooses of horsehair placed along their paths, in marshes and moist grounds. Wild ducks, in all their varieties, are taken in vast numbers every winter on our coasts, by means of decoys. See Decoy.

Grouse and partridges are taken by means of nets, either at night, when resting on the ground, by observing where they alight, and, when settled, drawing a net over that part of the field; or, in the day, a very steady dog is used to point at them. The attention of the birds being thus fixed, two persons, drawing the two extremities of a large net, pass it over them, and thus secure a whole pack of grouse, or covey of partridges, at once.

Pheasants are sometimes taken by night, by holding flaming sulphur under the trees on which they are observed to perch, the suffocating effluvia of which makes them fall senseless.

Bird *lime*. The vegetable principle, to which is given the name of bird-lime, was first examined by Vauquelin, who found it possessed of properties different from every other. It was found collected on the epidermis of a plant brought to Europe by Michaud, and called robinia viscosa, constituting a viscid substance, which made the fingers adhere to the young twigs. From the late analysis of bird-lime by Bouillon la Grange, it is obvious that it owes its peculiar properties to the presence of an analogous substance; which indeed constitutes the essential part of that composition. Hence the reason of the name of bird-lime to the principle itself. 1. Natural bird-lime (or that which exudes spontaneously from plants) possesses the following properties: its colour is green; it has no sensible taste or smell; is extremely adhesive; softens by the heat of the fingers, and sticks to them with great obstinacy. When heated, it melts, swells up, and burns with a considerable flame, leaving a bulky charcoal behind it. It does not dissolve in water; alcohol has but little action on it, especially when cold. By the assistance of heat, it dissolves a portion if it; but in cooling, allows the greatest part to precipitate again. When exposed to the air it continues glutinous, never becoming hard and brittle, like the resins. It combines readily with oils. Ether is its true solvent, dissolving it readily without the assistance of heat. The solution is of a deep green colour. The alkalies do not combine with it; the effect of the acids was not tried. These properties are sufficient to distinguish bird-lime from every other vegetable principle. 2. Artificial bird-lime is prepared from different substances in different countries. The berries of the misletoe are said to have been formerly employed. They were pounded, boiled in water, and the hot water poured off. At present, bird-lime is usually prepared from the middle bark of the holly. The process followed in England is as follows: the bark is boiled in water seven or eight hours, till it becomes soft. It is then laid in quantities in the earth, covered with stones, and left to ferment, or rot, for a fortnight or three weeks. By this fermentation, it changes to a mucilaginous consistency. It is then taken from the pits, pounded in mortars to a paste, and well washed with river water. Its colour is greenish, its flavour sour, and its consistence gluey, stringy, and tenacious. Its smell is similar to that of linseed oil. When spread on a glass plate, and exposed to the air and light, it dries, becomes brown, loses its viscidity, and may be reduced to a powder; but when water is added to it, the glutinous property returns. It reddens vegetable blues. When gently heated, it melts and swells, and emits an odour like that of animal oils. When heated on red hot coals, it burns with a lively flame, and gives out a great deal of smoke, leaving a white ash, composed of carbonate of lime, alumina, iron, sulphate, and muriate of potash. Weak acids soften bird-lime, and partly dissolve it; strong acids act with more violence. Sulphuric acid renders it black; and when lime is added to the solution, acetic acid and ammonia separate. Nitric acid, cold, has little effect; but when assisted by heat, it dissolves the bird-lime; and the solution, when evaporated, leaves behind it a hard brittle mass. By treating this mass with nitric acid, a new solution may be obtained, which, by evaporation, yields malic and oxalic acids, and a yellow matter, which possesses several of the properties of wax. Cold muriatic acid does not act on bird-lime; hot muriatic acid renders it black. Bird-lime, when treated with oxymuriatic acid, becomes white, and is divided into hard, compact masses, having unaltered bird-lime in their centre. This white substance may be pulverised; it is insoluble in water; does not melt when heated: and when treated with nitric acid, it neither becomes yellow, nor does it yield resin. Acetic acid softens bird-lime, and dissolves a certain portion of it. The liquid acquires a yellow colour. Its taste is insipid. When carbonate of potash is dropped into this solution, no precipitate falls. By evaporation it yields a resinous-like substance. Some of the metallic oxides are reduced when heated with bird-lime. Litharge combines with it, and forms a kind of plaster. Alcohol, of the specific gravity 0.817, dissolves bird-lime at a boiling heat. On cooling, it lets fall a yellow matter, similar to wax. The filtered liquid is bitter, nauseous, and acid. Water precipitates a substance similar to resin. Sulphuric ether dissolves bird-lime readily and in great abundance. The solution is greenish. When mixed with water, an oily substance separates, which has some resemblance to linseed oil. When evaporated, a greasy substance is obtained, having a yellow colour, and the softness of wax.

Birds' *nests*, in cookery, the nest of a small Indian swallow, very delicately tasted, and frequently mixed among soups. On the sea coasts of China, at certain seasons of the year, there are seen vast numbers of these birds; they leave the inland country at their breeding time, and come to build in the rocks, and fashion their nests out of a matter which they find on the shore, washed thither by the waves. The nature of this substance is scarcely yet ascertained. According to Kempfer, it is molluscæ or sea-worms; according to M. le Poivre, fish-spawn; according to Dalrymple, sea-weeds; and according to Linnæus, it is the animal substance frequently found on the beach, which fishermen call blubbers or jellies. The nests are of a hemispheric figure, and of the size of a goose's egg, and in substance much resemble the ichthyocolla or isinglass. The Chinese gather these nests, and sell them to all parts of the world; they dissolve in broths, &c. and make a kind of jelly, of a very delicious flavour. These nests are found in great abundance in the island of Sumatra, particularly about Croe, near the south end of the island. Four miles up the river of that name is a large cave, where the birds build in vast numbers. The nests are distinguished into white and black; of which the first are by far more scarce and valuable, being found in the proportion of one only to twenty-five. The white sort sells in China at the rate of 1000 to 1500 Spanish dollars the pecul; the black is usually disposed of at Batavia for about twenty dollars the same weight, where it is chiefly converted into glue, of which it makes a very superior kind. The difference between the two has by some been supposed to be owing to the mixture of the feathers of the birds with the viscous substance of which the nests are formed: and this they deduce from the experiment of steeping the black nests for a short time in hot water, when they are said to become in a great degree white. When the natives prepare to take the nests, they enter the caves with torches, and forming ladders, according to the usual mode, of a single bamboo notched, they ascend and pull down the nests, which adhere in numbers together, from the side and top of the rocks. They say that the more frequently and regularly the cave is stripped, the greater proportion of white nests they are sure to find, and that on this experirience they often make a practice of beating down and destroying the old nests in larger quantities than they trouble themselves to carry away, in order that they may find white nests the next season in their room. The birds, during the building time, are seen large flocks on the beach, collecting in their bills the foam which is thrown up by the surf, of which there is little doubt but they construct their nests, after it has undergone perhaps a preparation, from a commixture with their saliva, or other secretion, with which nature has provided them for that purpose.

Birds, *singing*, are, the mocking-bird, nightingale, blackbird, starling, thrush, linnet, lark, throstle, canary-bird, bulfinch, goldfinch, &c. See some very curious experiments and observations on the singing of birds. Phil. Trans. vol. lxiii. part ii. No. 31. Their first sound is called chirp, which is a single sound repeated at short intervals; the next call, which is a repetition of one and the same note; and the third sound is called recording, which a young bird continues to do for ten or eleven months, till he is able to execute every part of his song; and when he is perfect in his lesson, he is said to sing his song round. Their notes are no more innate than language in man; they all sing in the same key. The honourable author Daines Barrington has attempted to reduce their comparative merits to a scale; and to explain how they first came to have particular notes.

Birds, in heraldry, according to their several kinds, represent either the contemplative or active life. They are the emblems of liberty, expedition, readiness, swiftness, and fear. They are more honourable bearings than fishes, because they participate more of air and fire, the two noblest and highest elements, than of earth and water. Birds must be borne in coat-armour, as is best fitting the propriety of their natural actions of going, sitting, standing, flying, &c. Birds that are either whole footed, or have their feet divided, and yet have no talons, are said to be membered; but the cock, and all birds of prey, with sharp and hooked beaks and talons, for encounter or defence, are termed armed. In the blazoning of birds, if their wings be not displayed, they are said to be borne close; as he beareth an eagle, &c. close.

BIRTH. See Midwifery.

Birth, or **Birthing**, in the sea language, a convenient place to moor a ship in; also a due distance observed by ships lying at anchor, or under sail; and a proper place aboard for a mess to put their chests, &c. is called the birth of that mess.

BISCUIT, *sea*, is a sort of bread much dried, to make it keep for the service of the sea. It was formerly baked twice, or oftener, and prepared six months before the embarkation. It will keep good a whole year.

The process of biscuit-baking for the British navy is as follows, and it is equally simple and ingenious. The meal, and every other article, being supplied with much certainty and simplicity, large lumps of dough, consisting merely of flour and water, are mixed up together; and as the quantity is so immense as to preclude, by any common process, a possibility of kneading it, a man manages, or, as it is termed, rides a machine, which is called a horse. This machine is a long roller, apparently about four or five inches in diameter, and about seven or eight feet in length. It has a play to a certain extension, by means of a staple in the wall, to which is inserted a kind of eye, making its action like the machine by which they cut chaff for horses. The lump of dough being placed exactly in the centre of a raised platform, the man sits upon the end of the machine, and literally rides up and down throughout its whole circular direction, till the dough is equally indented; and this is repeated, till it is sufficiently kneaded; at which times, by the different positions of the lines, large or small circles are described, according as they are near to or distant from the wall.

The dough, in this state, is handed over to a second workman, who slices it with a prodigious knife; and it is then in a proper state for the use of those bakers who attend the oven. These are five in number; and their different departments are as well calculated for expedition and correctness, as the making of pins, or other mechanical employments. On each side of a large table, where the dough is laid, stands a workman; at a small table near the oven stands another; a fourth stands by the side of the oven to receive the bread; and a fifth to supply the peel. By this arrangement the oven is as regularly filled, and the whole exercise performed in as exact time, as a military evolution. The man on the further side of the large table moulds the dough, having previously formed it into small pieces, till it has the appearance of muffins, although rather thinner, and which he does two together, with each hand; and as fast as he accomplishes this task, he delivers his work over to the man on the other side of the table, who stamps them with a docker on both sides with a mark. As he rids himself of this work, he throws the biscuits on the smaller table next the oven, where stands the third workman, whose business is merely to separate the different pieces into two, and place them immediately under the hand of him who supplies the oven, whose work of throwing, or rather chucking the bread upon the peel, must be so exact, that if he looked round for a single moment, it is impossible he should perform it correctly. The fifth receives the biscuit on the peel, and arranges it in the oven; in which duty he is so very expert, that, though the different pieces are thrown at the rate of seventy in a minute, the peel is always disengaged in time to receive them separately.

As the oven stands open during the whole time of filling it, the biscuits first thrown in would be first baked, were there not some counteraction to such an inconvenience. The remedy lies in the ingenuity of the man who forms the pieces of dough, and who, by imperceptible degrees, proportionably diminishes their size, till the loss of that time which is taken up during the filling of the oven has no more effect to the disadvantage of one of the biscuits than to another.

So much critical exactness and neat activity occur in the exercise of this labour, that it is difficult to decide, whether the palm of excellence is due to the moulder, the marker, the splitter, the chucker, or the depositor; all of them, like the wheels of a machine, seeming to be actuated by the same principle. The business is, to deposit in the oven seventy biscuits in a minute; and this is accomplished with the regularity of a clock; the clack of the peel, during its motion in the oven, operating like the pendulum.

The biscuits thus baked are kept in repositories, which receive warmth from being placed in drying lofts over the ovens, till they are sufficiently dry to be packed into bags, without danger of getting mouldy; and when in such a state, they are then packed into bags of a hundred weight each, and removed into storehouses for immediate use.

The number of bake-houses belonging to the victualling-office at Plymouth are two, each of which contains four ovens, which are heated twenty times a day, and in the course of that time bake a sufficient quantity of bread for 16,000 men.

The granaries are large, and well constructed; when the wheat is ground, the flour is conveyed into the upper stories of the bake-houses, whence it descends, through a trunk in each, immediately into the hands of the workman.

The bake-house belonging to the victualling-office at Deptford consists of two divisions, and has twelve ovens, each of which bakes twenty shoots daily (Sundays excepted;) the quantity of flour used for each shoot is two bushels, or 112 pounds, which baked produce 102 pounds of biscuit. Ten pounds are regularly allowed on each shoot for shrinkage, &c. The allowance of biscuit in the navy is one pound for each man per day, so that one of the ovens at Deptford furnishes bread daily for 2,040 men.

BISCUTELLA, in botany, a genus of the Tetradynamia Siliculosa class and order. Natural order of Siliquosæ Cruciformes. Essential character; silicle compressed flat, rounded above and below, two-lobed; calyx, leaflets gibbous at the base. There are six species; of which B. auriculata, in a wild state, rises about a foot in height, but, in a garden, grows nearly two feet high, dividing into several branches; the flowers are produced at the end of the branches, in loose panicles, and are of a pale yellow colour; the nectareous gland is very large, and, consequently, the calyx is bagged out very much at bottom. Native of the south of France and Italy.

BISERRULA, in botany, a genus of the Diadelphia Decandria class and order. Natural order Papilionaceæ, or Leguminosæ. Essential character; legume two-celled, flat; partition contrary. There is but one species; *viz.* B. pelecinus, bastard hatchet vetch, an annual plant, which grows naturally in Italy, Sicily, Spain, and the South of France.

BISHOP, a prelate, or person consecrated for the spiritual government of a diocese.

Whether the distinction of bishops from mere priests or presbyters was settled in the apostolical age, or introduced since, is much controverted. It is certain, that in the New Testament the names of bishops and priests are used indiscriminately; but tradition, the fathers, and the apostolical constitutions, make a distinction. From this last consideration bishops are conceived as the highest ecclesiastical dignities, the chief officers in the hierarchy, or economy of church-government, as the fathers and pastors of the faithful, the successors of the apostles, and, as such, the superiors of the church of Christ.

Upon the vacancy of a bishop's see in England, the king grants his conge d'elire to the dean and chapter, to elect the person, whom, by his letters missive, he hath appointed; and if they do not make the election in twenty days, they are to incur a premunire. The dean and chapter having made their election accordingly, the archbishop, by the king's direction, confirms the bishop, and afterwards consecrates him by imposition of hands, according to the form laid down in the Common Prayer Book. Hence we see that a bishop differs from an archbishop in this, that an archbishop with bishops consecrates a bishop, as a bishop with priests consecrates a priest; other distinctions are, that an archbishop visits a province, as a bishop a diocese; that an archbishop convocates a provincial synod, as a bishop a diocesan one; and that the archbishop has canonical authority over all the bishops of his province, as a bishop has over the priests of his diocese.

The jurisdiction of a bishop of the church of England consists in collating benefices, granting institutions, commanding inductions, taking care of the profits of vacant benefices for the use of the successors, consecrating churches and chapels, ordaining priests and deacons, confirming after baptism, granting administrations, and taking probates of wills; these parts of his function depend upon the ecclesiastical law. By the common law, he is to certify to the judges concerning legitimate and illegitimate births and marriages; and to his jurisdiction, by the statute law, belongs the licensing of physicians, surgeons, and school masters, and the uniting of small parishes, which last privilege is now peculiar to the Bishop of Norwich.

All bishops of England are peers of the realm, except the Bishop of Man, and as such sit and vote in the House of Lords; they are barons in a three-fold manner, *viz.* feudal, in regard to the temporalities annexed to their bishoprics; by writ, as being summoned by writ to parliament; and lastly, by patent and creation; accordingly, they have the precedence of all other barons, vote as barons and bishops, and claim all the privileges enjoyed by the temporal lords, excepting that they cannot be tried by their peers, because, in cases of blood, they themselves cannot pass upon the trial, for they are prohibited by the canons of the church to be judges of life and death.

BISHOP'S *court*, an ecclesiastical court, held in the cathedral of each diocese, the judge whereof is the bishop's chancellor, who judges by the civil and canon law; and if the diocese be large, he has his commissaries in remote parts, who hold what they call consistory courts for matters limited to them by their commission.

BISHOPRIC, the district over which a bishop's jurisdiction extends, otherwise called a diocese.

In England there are twenty-four bishoprics, and two archbishoprics; in Scotland none at all; in Ireland eighteen bishoprics and four archbishoprics; and in Popish countries they are still more numerous.

BISMUTH, one of the brittle and easily fused metals. The ores of this metal are very few in number, and occur chiefly in Germany. This, in some measure, accounts for the ignorance of the Greeks and Arabians, neither of whom appear to have been acquainted with bismuth. The German miners, however, seem to have distinguished it at a pretty early period, and to have given it the name of bismuth; for Agricola describes it under that name as well known in Germany, and considers it as a peculiar metal. The miners gave it also the name of tectum argenti; and appear to have considered it as silver beginning to form, and not yet completed. Mr. Pott collected, in his dissertations on bismuth, every thing respecting it contained in the writings of the alchymists. Beecher seems to have been the first chemist, who pointed out some of its most remarkable properties. Bismuth is of a reddish white colour, and almost destitute both of taste and smell. It is composed of broad brilliant plates, adhering to each other. The figure of its particles, according to Hauy, is an octahedron, or two four-sided pyramids, applied base to base. Its specific gravity is 9.82. When hammered cautiously, its density, as Muschenbroeck ascertained, is considerably increased. It is not therefore very brittle: it breaks, however, when struck smartly by a hammer, and consequently is not maleable. Neither can it be drawn out into wire. Its tenacity, from the trials of Muschenbroeck, appears to be such, that a rod one eighteenth of an inch in diameter is capable of sustaining a weight of nearly 29*lbs.* When heated to the temperature of 476° it melts; and if the heat be much increased it evaporates, and may be distilled over in close vessels. When allowed to cool slowly, and when the liquid metal is withdrawn as soon as the surface congeals, it crystallizes in parallelopipeds, which cross each other at right angles. When kept melted at a moderate heat, it becomes covered with an oxide of a greenish grey or brown colour. In a more violent heat it is volatile, and may be sublimed in close vessels; but with the access of air, it emits a blue flame, and its oxide exhales in a yellowish smoke, condensible by cold bodies. This oxide is very fusible; and is convertible by heat into a yellow transparent glass. Sulphuric acid acts on bismuth, and sulphurous acid is disengaged. A part of the bismuth is dissolved, and the remainder is changed into an insoluble oxide. Nitric acid dissolves bismuth with great rapidity. To one part and a half of nitric acid, at distant intervals, add one of bismuth, broken into small pieces. The solution is crystallizable. It is decomposed when added to water; and a white substance is precipitated, called magistery of bismuth, or pearl-white. This pigment is defective, inasmuch as it is liable to be changed by sulphuretted hydrogen, and by the vapours of putrifying substances in general. Muriatic acid acts on bismuth. The compound, when deprived of water by evaporation, is capable of being sublimed, and affords a soft salt, which deliquesces into what has been improperly called butter of bismuth. Bismuth is capable of forming the basis of a sympathetic ink. The acid employed for this purpose must be one that does not act on paper, such as the acetic. Characters written with this solution become visible when exposed to sulphuretted hydrogen.

BISSECTION, in geometry, the division of a line, angle, &c. into two equal parts.

BISSEXTILE, or *leap-year*, a year consisting of 366 days, and happening every fourth year, by the addition of a day in the month of February, when that year consists of 29 days. And this is done, to recover the 6 hours which the sun takes up nearly in his course more than the 365 days commonly allowed for it in other years.

The day thus added was by Julius Cæsar appointed to be the day before the 24th of February, which among the Romans was the 6th of the calends, and which on this occasion was reckoned twice; whence it was called the bissextile. By the statute *De anno bissextile*, 21 Hen. III. to prevent misunderstandings, the intercalary day and that next before it are to be accounted as one day.

To find what year of the period any given year is, divide the given year by 4, then if 0 remains it is leap year; but if any thing remain, the given year is so many after leap year. But the astronomers concerned in reforming the calender in 1582, by order of Pope Gregory XIII. observing that in four years the bissextile added 44 minutes more than the sun spent in returning to the same point of the ecliptic; and computing that in 133 years these supernumerary minutes would form a day; to prevent any changes being thus insensibly introduced into the seasons, directed, that in the course of 400 years there should be three sextiles retrenched; so that every centesimal year, which is leap year according to the Julian account, is a common year in the Gregorian account, unless the number of centuries can be divided by 4 without a remainder. So 1600 and 2000 are bissextile; but 1700, 1800, and 1900 are common years.

The Gregorian computation has been received in most foreign countries ever since the reformation of the calender in 1582, excepting some northern countries, as Russia, &c. And by act of parliament, passed in 1751, it commenced in all the dominions under the crown of Great Britain in the year following; it being ordered by that act, that the natural day next following the 2nd of September should be accounted the 14th; omitting the intermediate 11 days of the common calendar. The supernumerary day in leap years being added at the end of the month February, and called the 29th of that month.

BISTOURY, in surgery, an instrument for making incisions, of which there are different kinds, some being of the form of a lancet, others straight and fixed in the handle like a knife, and others crooked with the sharp edge on the inside.

BISTRE, or Bister, among painters, denotes glossy soot, pulverised and made into a kind of cakes with gum-water.

BIT, or Bitts, in ship-building, the name of two great timbers usually placed abaft the manger in the ship's loof, through which the cross-piece goes; the use of it is to belay the cable thereto while the ship is at anchor.

BITCH, the female of the dog kind. See Canis.

BITTER, a sea term, signifying any turn of the cable about the bits, so as that the cable may be let out by little and little. And when a ship is stopped by a cable, she is said to be brought up by a bitter. Also that end of the cable which is wound about the bits is called the bitter end of the cables.

Bitter *principle*. The bitter taste of certain vegetables appears to be owing to the presence of a peculiar substance differing from every other in its chemical properties. It may be extracted from the wood of quassia, the root of gentian, the leaves of the hop, and several other plants, by infusing them for some time in cold water. The characters of this substance, originally described by Wether, have been attentively examined by Dr. Thompson, who enumerates them as follows. 1. When water thus impregnated is evaporated to dryness by a very gentle heat, it leaves a brownish yellow substance, which retains a certain degree of transparency. For some time it continues ductile, but at last becomes brittle. Its taste is intensely bitter. 2. When heated it softens, swells, and blackens; then burns away without flaming much, and leaves a small quantity of ashes. 3. It is very soluble in water and in alcohol. 4. It does not affect blue vegetable colours. 5. It is not precipitated by the watery solution of lime, barytes, or strontites; nor is it changed by alkalies 6. Tincture of galls, infusion of nut-galls, and gallic acid, produce no effect. 7. Of the metallic salts, nitrate of silver and acetate of lead are the only ones that throw it down. The precipitate by acetate of lead is very abundant; and that salt, therefore, affords the best test for discovering the bitter principle, when no other substances are present, by which also it is decomposed. From recent experiments of Mr. Hatchett, it appears that the bitter principle is formed, along with tan, by the action of nitric acid on indigo.

Bitter *salt, native*, in mineralogy, is of a greenish white, or smoke-grey colour. It occurs sometimes in earthy, sometimes in mass, and often in capillary crystals. When earthy it is without lustre, but when crystallized its lustre is between silky and vitreous. It consists of sulphate of magnesia, more or less mixed with iron and allumina, and probably some sulphate of allumina. It is found on the surface of decomposing argillaceous schistus, and sometimes of lime-stone.

BITTERN. See Ardea.

Bittern, in salt-works, the brine remaining after the salt is concreted: this they ladle off, that the salt may be taken out of the pan, and afterwards put in again; when being farther boiled it yields more salt.

BITTERSPATH, in mineralogy, is greyish, or greenish white, passing into asparagus green. It occurs: 1. disseminated or crystallized in rhomboids, or perfect or truncated at the solid angles; 2. short, somewhat oblique, tetrahedral prisms, often bevelled at the edges: 3. compressed hexaedrons. It is composed of

Carbonate of lime	52
——————— magnesia	45
Oxide of iron and manganese .	3
	100

BITUMEN, in chemistry. The term

bitumen has often been applied by chemists to all the inflammable substances that occur in the earth; but this use of the word is now so far limited, that sulphur and millite are most commonly excluded. It would be proper to exclude amber likewise, and to apply the term to those fossil bodies only which have a certain resemblance to oily and resinous substances. Bituminous substances may be subdivided into two classes, namely, bituminous oils, and bitumens, properly so called. The first set possesses nearly the properties of volatile oils, and ought, in strict propriety, to be classed with these bodies; but as the chemical properties of bitumens have not yet been investigated with much precision, it is deemed rather premature to separate them from each other. The second set possess properties peculiar to themselves. Only two species of bituminous oils have been hitherto examined by chemists. Others indeed have been mentioned; but their existence has not been sufficiently authenticated. These two species are called petroleum, and maltha, or sea-wax; the first is liquid, the second solid. See PETROLEUM and MALTHA.

The true bituminous substances may be distinguished by the following properties:—They are either solid, or of the consistence of tar: their colour is usually brown or black: they have a peculiar smell, or at least acquire it when rubbed; this smell is known by the name of the bituminous odour; they become electric by friction, though not insulated; they melt when heated, and burn with a strong smell, a bright flame, and much smoke: they are insoluble in water and alcohol, but dissolve most commonly in ether, and in the fixed and volatile oils; they do not dissolve in alkaline leys, nor form soap; acids have little action on them; the sulphuric scarcely any; the nitric, by long and repeated digestion, dissolves them, and converts them into a yellow substance, soluble both in water and alcohol, and similar to the product formed by the action of nitrous acid on resins. The bitumens at present known may be reduced to three; namely, asphaltum, mineral tar, and mineral caoutchouc. Bitumen has been found also united to a resinous compound, in a curious substance first accurately examined by Mr. Hatchett, to which he has given the name of retinasphaltum. United to charcoal in various proportions, it constitutes the numerous varieties of pit-coal, so much employed in this country as fuel. The asphaltum found in Albania is supposed to have constituted the chief ingredient of the Greek fire. Asphaltum is seldom absolutely pure; for when alcohol is digested on it, the colour of the liquid becomes yellow, and by gentle evaporation a portion of petroleum is separated. Mineral tar seems to be nothing else than asphaltum, containing a still greater proportion of petroleum. When alcohol is digested on it, a considerable quantity of that oil is taken up; but there remains a black fluid substance like melted pitch, not acted upon by alcohol, and which therefore appears to possess the properties of asphaltum, with the exception of not being solid. By exposure to the air, it is said gradually to assume the state of asphalum.

BIVALVES, one of the three general classes in Conchology, comprehending all those, the shells of which are composed of two pieces, joined together by a hinge.

The Linnean genera of bivalve shells are the following fourteen:

Anomia
Arca
Cardium
Chama
Donax
Mactra
Mya
Mytillus
Ostrea
Pinna
Solen
Spondylus
Tellina
Venus.

BIXA, in botany, a genus of Polyandria Monogynia class and order. Natural order of Columniferæ: Tiliacæ, Jussieu. Essential character: corolla ten petalled; calyx five-toothed; capsule hispid, bivalve. B. ænellana is a shrub with an upright stem, eight or ten feet high, sending out many branches at the top, forming a regular head; these are garnished with heart-shaped leaves ending in a point; the flowers are produced in loose panicles, at the end of the branches, of a pale peach colour, having large petals. There is but one species, which is a native both of the East and West Indies.

BLACK, something opake and porous, that imbibes the greatest part of the light that falls on it, reflects little or none, and therefore exhibits no colour. Bodies of a black colour are found more inflammable, because the rays of light falling on them are not reflected outwards, but enter the body, and are often reflected and refracted within it, till they are stifled and lost. They are also found lighter, *cæteris paribus*, than white bodies, being more porous. It may be added, that clothes dyed of this colour wear out faster than those of any other, because their substance is more penetrated and corroded by the vitriol necessary to strike their dye, than other bodies are by the galls and alum which suffice for them. The inflammability of black bodies, and their disposition to acquire heat, beyond those of other colours, are easily evinced. Some appeal to the experiment of a white and black glove worn in the same sun; the consequence will be, a very sensibly greater degree of heat in the one hand than the other. Others allege the phenomena of burning-glasses, by which black bodies are always found to kindle soonest; thus, a burning-glass, too weak to have any visible effect at all upon white paper, will readily kindle the same paper rubbed over with ink.

Dr. Watson, the present Bishop of Landaff, covered the bulb of a thermometer with a black coating of India ink, in consequence of which the mercury rose ten degrees. Phil Trans. vol. lxiii. Black clothes heat more, and dry sooner in the sun, than white clothes. Black is therefore a bad colour for clothes in hot climates: but a fit colour for the linings of ladies summer hats,

Black *act*, in law, so called from the devastations committed in Hampshire by persons in disguise, or with their faces blacked; to prevent which, it is enacted by 31 George II. c. 42, that persons hunting, armed, and disguised, and killing or stealing deer, or robbing warrens, &c. or setting fire to any house, barn, or wood, or shooting at any person, or sending anonymous letters, or letters signed with a fictitious name, demanding money, &c. or rescuing such offenders; are guilty of felony without benefit of clergy.

Black, *bone*, is made with the bones of oxen, cows, &c. and is used in painting; but is not so much esteemed as ivory-black.

Black, *currier's*, a black made with gall-nuts, sour beer, and old iron, termed the first black. The second black, which gives the gloss of the leather, is composed of gall-nuts, copperas, and gum-arabic.

Black *earth*, a sort of coals found in the ground, which the painters and limners use to paint in fresco, after it has been well ground.

There is also a black made with gall-nuts, copperas, or vitriol, such as common ink. And a black made with silver and lead, which serves to fill up the cavities of engraved things.

Black, *ivory*, otherwise called velvet-black, is burnt ivory, which becoming quite black, and being reduced to thin plates, is ground in water, and made into troches, to be used by painters, and by jewellers, who set precious stones to blacken the ground of the collets, and give the diamonds a teint or foil In order to be good, it ought to be tender, friable, and thoroughly ground.

Black, *lamp*, the sooty smoke of rosin. There is some in powder and some in lumps, and is mostly brought from Swedon and Norway. It is used on various occasions, particularly for making the printer's ink, for which purpose it is mixed with oil of walnuts, or linseed, and turpentine, all boiled together.

Black *lead* has long been known under the name of plumbago; it is however properly denominated in the modern chemistry, according to its component parts, a carburet of iron, it being compounded of 90 parts of carbon, and 10 iron. See **Iron**, where its properties will be described.

Black-lead is found in different countries, but the very best, and the fittest for making pencils, is found at Burrowdale in Cumberland, where it is obtained in such plenty, that not only the whole Island of Great Britain, but the Continent of Europe may be said to be supplied from thence. Beside the application of this substance to the manufacture of pencils, it is made into retorts that will endure almost the strongest heat. The powder of black-lead is used in covering the straps for razors, and with it stoves, &c. are preserved from rust.

Black *rod, gentleman usher of*, in Brirish customs, is chief gentleman to the King. He has also the keeping of the chapter-house door, when a chapter of the Order of the Garter is sitting; and in time of parliament attends on the House of Peers.

BLACKBURNIA, in botany, so called in honour of John Blackburne, Esq. and his daughter Anna, of Orford in Lancashire: a genus of the Tetrandria Monogynia class and order. Essential charactea: calyx four-toothed; petals four, elliptic; anthers heart-shaped; germ conic; stigma simple; pericarp, berry, with a single seed. There is but one species, *viz.* bipinnata, has the leaves alternate; abruptly pinnate, with two or three pairs of leaflets, which are opposite, quite entire, and very smooth; panicles axillary, smaller. It is in habit not unlike ptelea trifoliata, and whether it ought to be separated from that genus cannot be determined, till we are better acquainted with the fruit. It is a native of Norfolk Island.

BLACKWELLIA, in botany, a genus of the Dodecandria Pentagynia class and order. Calyx five-cleft, half superior; corol fifteen petalled; capsules one celled, many-seeded. There are three species in the Asiatic islands.

BLADHIA, in botany, so named from Peter John Bladh, a Swede, a genus of the Pentandria Monogynia class and order. Essential character: calyx wheel-shaped, deciduous; berry containing one arilled seed. There are three species, all natives of Japan. B. of which japonica has a perennial root, with small fibres, a shrubby stem, flexuoses erect, very thinly branched, from four inches to a foot high. Flowers axillary; corolla white; sweet smelling.

BLADDER, a thin membranous substance, found in several parts of an animal, serving as a receptacle of some juice, or of some liquid excrement, as the uninary bladder, gall bladder, &c. See ANATOMY.

BLADE, in commerce, a slender piece of metal, designed for cutting: thus, we meet with sword-blade, blade of a chissel, blade of a saw, &c.

BLÆRIA, in botany, a genus of the Tetrandria Monogynia class of plants, the flower of which is monopetalous and campanulated: the tube is cylindric, of the length of the cup, and pervious: the limb is small, and divided into four oval reflex segments: the fruit is an oblong quadrangular capsule, with four cells, containing several roundish seeds. There are six species, all found at the Cape of Good Hope.

BLAIR (JOHN,) an eminent chronologist, was educated at Edinburgh. Afterward, coming to London, he was for some time usher of a school in Hedge-lane. In 1754 he first published "The Chronology and History of the World, from the Creation to the year of Christ 1753;" illustrated in 56 tables. In 1755 he was elected a Fellow of the Royal Society, and in 1761 of the Society of Antiquaries. In 1756 he published a 2d edition of his "Chronological Tables;" and in 1768 an improved edition of the same, with the addition of 14 maps of ancient and modern geography, for illustrating the Tables of Chronology and History; to which is prefixed a "Dissertation on the Progress of Geography." In 1757 he was appointed chaplain to the Princess Dowager of Wales, and mathematical tutor to the Duke of York, whom he attended in 1763 in a tour to the continent, from which they returned the year after. Dr. Blair had successively several good church livings: as, a prebendal stall at Westminster, the vicarage of Hinckley, and the rectory of Burton Coggles in Lincolnshire, all in 1761, the vicarage of St. Bride's in London, in 1771, in exchange for that of Hinckley; the rectory of St. John the Evangelist in Westminster, in 1776, in exchange for the vicarage of St. Bride's; in the same year the rectory of Horton, near Colebrooke, Bucks. Dr. Blair died the 24th of June, 1782.

BLAKEA, in botany, so named from Martin Blake, of Antigua, a genus of the Dodecandria Monogynia class and order. Essential character: calyx inferior, six-leaved; superior, entire; petals six; capsules six-celled, many-seeded. There are but two species, of which B. trinervia generally grows to the height of ten or fourteen feet; but rises higher when it remains a climber, in which state it continues some time. It is one of the most beautiful productions of America. It supports itself for a time by the help of some neighbouring shrub or tree, but it grows gradually more robust, and at length acquires a pretty moderate stem, which divides into a thousand weakly declining branches, well supplied with beautiful rosy blossoms on all sides. It is a native of Jamaica, in cool moist shady places.

BLANCHING *of copper* is done various ways, so as to make it resemble silver. If it be done for sale, it is felony by 8 and 9 William III. ch. xxvi.

BLANCHING, in coinage, the operation performed on the planchets or pieces of silver, to give them the requisite lustre and brightness. They also blanch pieces of plate, when they would have them continue white or have only some parts of them burnished.

Blanching, as it is now practised, is performed by heating the pieces on a kind of peel with a wood-fire, in the manner of a reverberatory, so that the flame passes over the peel. The pieces being sufficiently heated, and cooled again, are put successively to boil in two pans, which are of copper: in these they put water, common salt, and tartar of Montpelier. When they have been well drained of this water in a copper sieve, they throw sand and fresh water over them; and, when dry, they are well rubbed with towels.

BLANCHING, among gardeners, an operation whereby certain sallets, roots, &c. are rendered whiter than they would otherwise be. It is this: after pruning off the tops and ends of the plants to be blanched, they plant them in trenches about ten inches wide, and as many deep, more or less, as is judged necessary; as they grow up, care is taken to cover them with earth, within four or five inches of their tops: this is repeated, from time to time, for five or six weeks, in which time they will be fit for use, and of a whitish colour, where covered by the earth.

BLANK, in commerce, a void or unwritten place, which merchants sometimes leave in their day-books or journals. It is also a piece of paper, at the bottom of which a person has signed his name, the rest being void. These are commonly intrusted into the hands of arbiters, to be filled up as they shall think proper, to terminate any dispute or lawsuit.

Blank *verse*, in the modern poetry, that composed of a certain number of syllables, without the assistance of rhyme. See Poetry.

BLASIA, in botany, a genus of the Cryptogamia Hepaticæ class and order. Male solitary; imbedded in the frond: female no calyx: capsule imbedded in the frond, oblique, one-celled, with a tubular mouth; seeds numerous. There is one species, a native of England.

BLASPHEMY, an indignity or injury offered to the Almighty, by denying what is his due, and of right belonging to him; or by attributing to the creature that which is due only to the creator.

Blasphemy, among the Jews, was punished by stoning the offender to death. With us, it is punishable at common law, by fine and pillory. And by a statute of William III. if any person shall, by writing or speaking, deny any of the persons in the Trinity, he shall be incapable of any office; and for the second offence, be disabled to sue in any actions, to be an executor, &c.

BLAST, in a general sense, denotes any violent explosion of air, whether occasioned by gunpowder, or by the action of a pair of bellows.

Blast, a disease in grain, trees, &c. The sugar-cane, in the West Indies, is very subject to a disease of this kind, occasioned perhaps by one or more species of the aphides. The disease is distinguished into the black and yellow: the latter is the most destructive. It consists of insects invisible to the naked eye, whose proper food is the juice of the cane, in search of which they wound the tender blades, and in the end destroy the whole.

BLASTING, a term used by miners for the tearing up rocks which lie in their way by the force of gunpowder. In order to do this, a long hole is made in the rock, which being charged with gunpowder, they will it up; leaving only a touch-hole, with a match to fire the charge.

Blasting *of wood*, the rending in pieces logs of wood, such as roots of trees, &c. by means of gunpowder. A method has been lately described by Mr. Knight, which is simple, and easily effected. The instrument used is a screw, with a small hole drilled through its centre. The head of the screw is formed into two strong horns, for the more ready admission of the lever with which it is to be turned, and a wire, for the purpose of occasionally clearing the touch-hole. When a block of wood is to be broken, a hole is to be bored with an auger to a proper depth, and a charge of gunpowder introduced. The screw is to be turned into the hole till it nearly touches the powder; a quick match is then to be put down the touch-hole till it reaches the charge. The quick match is eighteen inches long, to afford the operator an opportunity of retiring, after lighting it, to a place of safety: it is made by steeping a roll of twine or linen thread in a solution of saltpetre.

BLATTA, the *cock-roach*, in natural history, a genus of insects of the order Hemiptera. The generic characters are, head inflected; antennæ setaceous; wings flat, subcoriaceous; thorax flattish, orbicular, margined; feet formed for running; hornlets two over the tail. The insects of this genus, and their larvæ, wander about by night, and secrete themselves by day. They are fond of warmth, and haunt houses, devouring meal, and whatever provisions they can get at: they run with great celerity, and are destroyed by the fumes of charcoal. In hot climates they are a great pest to society, by not only devouring whatever they can get at, but some of the species leave a very unpleasant smell, which is apt to remain a considerable time on the articles which they have passed over. The largest of the genus is, as its name imports, the B. gigantea, a native of many of the warmer parts of Asia, Africa, and South America, of which the following account is given by Drury in his "Exotic Insects." "The cock-roach," says he, "are a race of pestiferous beings, equally noisome and mischievous to natives and strangers, but particularly to collectors. These nasty and voracious insects fly out in the evenings, and commit monstrous depredations: they plunder and erode all kinds of victuals, drest and undrest, and damage all sorts of clothing, especially those which are touched with powder, pomatum, and similar substances; every thing made of leather, books, paper, and various other articles, which, if they do not destroy, at least they soil, as they frequently deposit a drop of their excrement where they settle, and some way or other by that means damage what they cannot devour. They fly into the flame of candles, and sometimes into the dishes; are very fond of ink and oil, into which they are apt to fall and perish. In this case they turn most offensively putrid, so that a man might as well sit over the cadavarous body of a large animal, as write with the ink in which they have died. They often fly into persons' faces or bosoms, and their legs being armed with sharp spines, the pricking excites a sudden horror not easily described. In old houses they swarm by myriads, making every part filthy beyond description wherever they harbour, which in the day-time is in dark corners, behind all sorts of clothes, in trunks, boxes, and in short every place where they can lie concealed. In old timber and deal houses, when the family is retired at night to sleep, this insect, among other disagreeable properties, has the power of making a noise, which very much resembles a pretty smart knocking with the knuckle upon the wainscotting. The B. gigantea, in the West Indies, is therefore frequently known by the name of the drummer. Three or four of these noisy creatures will sometimes be impelled to answer one another, and cause such a drumming noise, that none but those who are very good sleepers can rest for them. What is most disagreeable, those who have not gause curtains are sometimes attacked by them in their sleep: the sick and the dying have their extremities attacked, and the ends of the toes and fingers of the dead are frequently stripped both of the skin and flesh. This insect is not at present known in Europe, though many of the other species, of which Gmelin enumerates 47, have been introduced by ships from the warmer regions, and are become nuisances in our houses. It has been supposed that the gigantea has been seen once at least in our own country, concerning which Mouffet writes: "I have heard from people worthy of credit, that one of the blattæ was found on the roof of Peterborough church, which was six times larger than the common blatta, and which not only pierced the skin of those who endeavoured to seize it, but bit so deep as to draw blood very copiously: it was as large as ones's thumb, and being confined in the cavity of the wall, after two or three days it made its escape, unnoticed by any one." In Asia this species is as large as a good sized hen's egg. B. orientalis, or black cockroach, is found in America, and has long been naturalized in Europe: female with mere rudiments of wing-cases and wings: egg subcylindrical with a crenate ridge, and half as large as the abdomen. B. americana is native of America, and has of late years appeared in Europe, having been taken over in raw sugar. It is of a feruginous colour, the shield of the thorax whitish behind. B. irrorata is nearly as large as B. gigantea, and is a native of New Holland; head pale; front subferuginous; the hind margin brown; wing-cases with an abbreviated black line at the base.

BLAZONING, or **Blazonry**, in heraldry, the art of decyphering the arms of noble families. The word originally signified the blowing or winding of a horn, and was introduced into heraldry as a term denoting the description of things borne in arms, with their proper significations and intendments, from an ancient custom the heralds, who were judges, had of winding a horn at jousts and tournaments, when they explained and recorded the achievments of knights.

In blazoning a coat of arms, you must always begin with the field, and next proceed to the charge; and if there be many things borne in the field, you must first name that which is immediately lying on the field. Your expressions must be very short and expressive, without any expletives, needless repetitions, or particles. Such terms for the colours must be used as are agreeable to the station and quality of the bearer. All persons beneath the degree of a noble must have their coats blazoned by colours and metals, noblemen by precious stones, and kings and princes by planets.

BLEACHING, in the arts, is a process that consists of a series of operations, partly chemical and partly mechanical, to which vegetable and animal fibres are subjected, for the purpose of discharging their natural colour, and thus rendering them white, either before or after they have been manufactured. Now as almost all the articles of clothing are formed of vegetable or animal fibres, and as these are, for the most part, required to be made as white as possible, either to be worn in this state, or as preparatory to being dyed or printed, it is obvious that the art of bleaching is one of great importance. The substances upon which the bleacher is required to exercise his art are, cotton, flax, hemp, wool, and silk. The three former, being of vegetable origin, require a somewhat similar treatment, which in many particulars differs from that which is applicable to the two latter.

The art of bleaching consists, not merely in discharging the colour of the thread, but likewise in removing the colouring matter itself, as otherwise a sensible shade would be retained. In the old method this was attained by alternate exposure of the thread or cloth to the action of light, humidity, and atmospheric air, and to an alkaline ley, the cloth being macerated in a solution of potash, exposed on the field to the air and sun, and frequently sprinkled with water; and these alternate practices being continued until the bleaching was complete. In the new method, the action of the oxymuriatic acid is substituted for that of the light, air, and water; and it answers the same purpose by affording oxygen to the colouring matter, thus impairing the colour, and probably rendering the matter soluble in the alkaline solution.

At first this process was performed by exposing the cloth to the action of the pure acid in the state of gas. It was found, however, to act unequally on the cloth, the texture being injured in one part, while in another it was imperfectly whitened. The solution of it therefore in water was substituted, and even this requires to be considerably diluted. The bleaching liquor, according to the directions given by Berthollet, is prepared by putting six parts of black oxide of manganese, and sixteen of muriate of soda, into a glass or earthern retort, or a leaden bottle, and pouring upon them twelve parts of sulphuric acid, diluted with nine of water. The retort, or bottle, is connected by a tube with a receiver, designed to retain any common muriatic acid that may pass over: from this vessel another tube issues, which is inserted in a large wooden cask filled with water. The tube descends nearly to the bottom of the cask, so that the gas has to rise through the whole body of the water, at the same time the absorption of it is promoted by the motion of a circular frame placed in the middle of the cask, and which can be turned round at the top. The oxygenated acid is thus easily condensed. After the first disengagement of the gas has ceased, heat is applied to the retort, by placing it in a sand bath, or if a leaden bottle be used, by placing it in a vessel of boiling water. So much water is used that the oxygenated acid is very weak; it requires to be stronger for coarse than fine cloth, and for linen than for cotton; the average quantity stated by Berthollet is 100 quarts for every pound of muriate of soda that has been used. The cloth to be bleached is prepared by macerating it in warm water for some hours, to take up what part of the colouring matter may be soluble. It is then boiled in an alkaline ley, prepared from 20 parts of water and one part of the potash of commerce, rendered more active by having been mixed with one-third of lime. After sufficient boiling, it is washed with water, and put into close wooden troughs, containing the oxygenated acid, in which it is allowed to macerate for three or four hours, pressing the cloth frequently, and exposing its surfaces to the action of the liquor. It is thus alternately exposed to the action of the alkaline ley and the oxygenated acid, till its colouring matter is completely extracted, or it is sufficiently bleached, which requires in general from four to eight immersions, according to the nature and coarseness of the cloth, cotton requiring fewer immersions in the bleaching liquor than linen. The subsequent steps of the process are, to rub the cloth strongly with soft soap in warm water. This renders the surface more smooth and uniform, and takes away the smell of the oxygenated acid, which otherwise remains a considerable time. The cloth is again washed, and is lastly immersed for a short time in water, in which, from one-sixtieth to a hundredth part of sulphuric acid has been dissolved. The cloth thus acquires a much finer whiteness, from the sulphuric acid dissolving the remaining colouring matter, which has resisted the action of the alkali and oxygenated acid, as well as a small quantity of iron and calcareous earth contained in all vegetable matter, or even deposited in the cloth by the alkaline leys. Lastly, the cloth is generally exposed to the air for some days, and watered, to carry off any remains of either of the acids, and to remove completely the odour of the oxygenated acid. The theory of the action of the oxygenated muriatic acid in bleaching is very simple, as stated by Berthollet. Its analogy to the common process by exposure to the air and light, he observes, is complete. The end obtained by either is the combination of oxygen with the colouring matter of the vegetable. By this combination the colour is nearly destroyed, and the matter on which it depends is at the same time rendered soluble in the alkaline solution. Hence the necessity of the alternate application of these two chemical agents; the one removing from the cloth what the other has rendered soluble, and which, although whitened, would regain part at least of its colour in time. Hence it is found, that the oxygenated muriatic acid is, in this operation, converted into common muriatic acid, and the alkaline solution is at length so loaded with colouring matter, that it becomes unfit to be used. The only difference between the two methods is, that in the one the oxygen is presented in a much more concentrated state than in the other, which facilitates the process, or renders it more rapid without injuring the strength of the fibre. At least, the only injury of this kind that can happen must arise from improper management; having used too strong an acid, or the not washing the cloth sufficiently after the process is finished. The greatest difficulty attending the use of oxymuriatic acid arose from its suffocating odour, which rendered it almost impossible to work with it in an open vessel, and any apparatus contrived to turn the cloth and expose fresh surfaces of it to the action of the liquid in close vessels, has been found imperfect. The addition of an alkali to the liquid removes in a great measure the odour of the acid, or at least prevents its unpleasant effects; and although it at the same time diminishes to a certain extent its bleaching power, this is more than compensated for by the advantage. The quantity of alkali added amounts to about 1*lb.* of the potash or pearlash of commerce to the quantity of acid prepared from 4*lbs.* of muriate of soda. And to avoid the effervescence which would arise from the disengagement of the carbonic acid, during the combination of the oxymuriatic acid, the potash is deprived of it by the previous addition of lime, the alkaline solution after its operation being poured off clear.

Independently of the weakening of the power of the acid by this addition, a considerable expense was introduced by the use of the alkali; and it became an object of importance to the manufacturers of this country to substitute a cheaper substance, which should have the same effect. Lime was tried at first in an imperfect manner, but at length with such improvements, that it is now always used. The difference of using it arose from the insolubility of the lime in water, the quantity taken up being so inconsiderable, that the solution could have little effect in correcting the odour of the acid. A very important improvement, therefore, was that of using lime suspended in water, and kept in suspension by an agitation in a close vessel, into which the gas was transmitted. Its condensation was thus facilitated, and the compound which is formed with the lime being soluble in water, the undissolved or unsaturated lime was allowed to subside, and the clear liquor was fit for the purpose of bleaching.

An improvement, however, of still more importance, has been made by Mr. Tennant of Glasgow, and a patent obtained for it; *viz.* that of combining the oxymuriatic acid with dry lime, and dissolving a certain proportion of this compound in water, to form a bleaching liquor. It perhaps could scarcely have been supposed that such a combination could have been formed, so as to retain the powers of the acid. But the trial has fully succeeded, and the advantages derived from it are important; the compound can be carried easily to a distance, and the manufacturer need not prepare it himself, which is always an advantage, especially where he does not work on a large scale. The combination is formed by introducing the oxymuriatic acid gas through leaden tubes into slacked lime, prepared from chalk, by which it is absorbed. Solutions of this are prepared of different strengths, according to the purposes to which they are to be applied, the strength being judged of by the hydrometer, and by the quantity requisite to destroy the colour of a diluted solution of indigo in sulphuric acid. The process of bleaching, as now performed by these liquors, differs little from that which has been already described as executed by the solution of the oxymuriatic acid alone in water. To these methods, however, is to be added the more recent discovery of bleaching by an alkali, assisted by watery vapour and a high temperature, and which, either alone or combined to a certain extent with the method by the oxymuriatic acid, is now practised with so much advantage. In this method, which has been long in use in some of the eastern countries, and of which notice was first given by Chaptal, the cloth or thread is impregnated with a solution of potash or soda, rendered active by the carbonic acid having been entirely abstracted from the alkali by lime; it is suspended loosely, and, with an extensive surface, in a close boiler, a quantity of the same solution being in the bottom, and heat is applied, the boiler being closed, with a safety valve in the cover, so that the vapour under pressure may receive a high temperature. It is kept in this situation for a number of hours. The thread or cloth when cold is washed, and either exposed on the field, or subjected to the action of the oxymuriatic acid in some of the forms under which it has been used. It is thus at once rendered perfectly white. The superiority of this method probably arises from the high temperature, and the solvent power of the watery vapour, favouring the action of the alkali on the colouring matter, while this vapour penetrates the fibres of the cloth so effectually, that the matter is in a great measure dissolved and removed.

The animal fibres that are subjected to the bleaching process are wool and silk. These cannot be treated in the same manner as vegetable substances: a strong alkaline ley will dissolve them, and oxymuriatic acid will both weaken them and turn them yellow. The colour of manufactured wool resides partly in its own oil, and partly in the greasy and mucilaginous applications which it receives in being prepared for the loom. Both the one and the other are easily got rid of, by the action of fuller's earth and soap in the process of fulling. Fuller's earth is a very fine-grained absorbent earth, which by itself is capable of mixing rather than combining with vegetable or animal oils, and rendering them miscible with water: its action is found, however, to be increased by the addition of soap; and woollen cloth being beat in a fulling-mill with hot water, and a proper mixture of earth and soap, or of soap alone, and afterwards well washed and dried in the air, receives all the bleaching which it requires, or is indeed capable of. It is then of a white colour, somewhat verging towards yellow: this last tinge may be made to disappear, by the addition of a very small quantity of stone blue in the water in which the cloth is last washed, or by exposing it to the fumes of burning sulphur. By this latter method, however, it acquires a certain harshness of feel, and is apt to turn very yellow when washed with soap. Both the colour and harshness of raw silk depend entirely on a yellow varnish with which it is naturally covered. This varnish may be in part removed by long boiling in simple water. It is coniderably more soluble in alcohol; but the most effectual and expeditious way of clearing is by putting it in a linen bag, and boiling it for some hours in a solution of white soap in water, then rincing it in clean water, and repeating the process till it is quite white, and exhibits the peculiar lustre of this beautiful substance. Some of the French chemists have endeavoured to lessen the consumption of soap, by proposing various substitutes; but nothing is so effectual and expeditious as the purest white soap, and the article itself is so valuable, as amply to repay this expense.

The oxymuriatic acid has also been used from its bleaching power in the manufacture of paper; either the linen rags from which the paper is to be made being blanched by it, or, what has been regarded as preferable, the pulp into which they are reduced being submitted to its action. This method, though once extensively practised in this country, has been relinquished by many of our paper-manufacturers, as it has been found, that in paper prepared with it, in the course of a few years, the ink is altered, and its blackness even so much impaired, as to afford some reason for the suspicion that in time it will altogether fade; nor is this confined to writing ink, but has been observed even in printing ink. The effect is no doubt to be ascribed to a slight impregnation of the oxymuriatic acid; and this indeed can often be rendered perceptible by its odour, by breathing on paper which has been bleached in this manner. It might no doubt be removed by very careful washing of the pulp; but we have been informed by some intelligent paper manufacturers, that the additional labour which would be requisite for this would upon the whole render the method more expensive than the old one.

The process of bleaching by steam with an alkali at a high temperature might probably be advantageously employed. A branch of the manufacture, however, in which the acid necessarily must be used, is that of discharging the colours from coloured rags, or to remove the ink from waste written paper. Even printed paper has been whitened by its agency, combined with that of an alkali, to remove the oily matter, and made to afford at least a coarser kind of paper. Chaptal applied it to the purpose of restoring the colour of old books or prints, the paper being whitened by a very dilute acid, which did not act sensibly on the printing ink.

Wax, reduced to thin plates, has been

bleached by the oxymuriatic acid. The process succeeds best when the acid is used in the state of gas. Berthollet has announced a peculiar effect obtained from the action of oxymuriatic acid, that of giving the appearance of cotton to hemp or flax. The process consists in immersing the flax, prepared by boiling, and by an alkaline solution in oxymuriatic acid of a certain strengh, for some time, and alternating this immersion repeatedly with the action of an alkaline ley.

BLECHNUM, in botany, a genus of the Cryptogamia Filices, or Ferns. There are six species, all of them natives of warm or hot countries, excepting B. virginicum, which will bear the open air of England. They are increased by parting the roots.

BLENDE. See ZINC.

BLENNIUS, *blenny*, in natural history, a genus of fishes of the order Jugulares. The generic characters are, head sloping; body lengthened, sub-compressed, lubricous; gill membrane six-rayed; ventral fins two, three or four-rayed, unarmed; anal fin distinct. There are two divisions; *viz.* A. head crested B. head not crested; and according to Gmelin there are 18 species, though Dr. Shaw enumerates more. B. galerita, or crested blenny, inhabits the European ocean, is four or five inches long; its body is brown and spotted; the skin at the corner of the upper jaw loose, projecting; dorsal fin extending from the head almost to the tail; ventral fin small; vent under the ends of the pectoral fin. This fish is frequently found about the rocky coasts of Great Britain. B. ocellaris has above the eyes a single ray, and on the first dorsal fin a large black ocellate spot. It inhabits the Mediterranean Sea; is eight inches long; the body is without scales, dirty green, with olive streaks, rarely pale blue: the flesh is eatable, but in no great estimation. Although Linnæus and others have described this fish as having two dorsal fins, Block considers it as having in reality but one, the sinking in of the middle part being in some specimens much deeper than in others, seems to be the cause of this difference of opinion. B. saliens is a very small species, observed about the coasts of some of the southern islands, and particularly those of New Britain. It seems to be of a gregarious nature, and is seen swimming by hundreds, and flying as it were over the surface of the water, occasionally springing among the rocks. It is naturally formed for celerity in its movements, the pectoral fins being very large in proportion to the body. They are nearly of a circular form when expanded, and when contracted reach almost as far as the vent on each side. B. superciliosus has a small head, with large eyes, and silvery irides, and immediately over each eye is situated a small palmated crest, or appendage, divided into three segments. The body is covered with very small scales, and is of a yellow or gilded tinge, and marked with numerous and irregular spots of dusky red. The dorsal fin commences at the back part of the head, and is continued almost to the tail; but near its commencement suddenly sinks, so as almost to give the appearance of a smaller anterior dorsal fin, separate from the longer one: the pectoral fins are of moderate size; the ventral ones didactyle, and rather long: the vent is situated in the middle of the abdomen, from which part the anal fin commences, and reaches as far as the tail. This species is found native in the Indian seas, grows to the length of about twelve inches, and is viviparous. There is, however, another species, denominated B. viviparus, which, like that just noticed, is distinguished by a particularity that takes place in but very few fishes, except those of the cartilaginous tribe; being viviparous, the ova hatching internally, and the young acquiring their perfect form before the time of birth. Not less than two, or even three hundred of these have been sometimes observed in a single fish. It might be imagined that so great a number, confined in so small a space, might injure each other by the briskness of their motion; but this is prevented by the curious disposition of fibres and cellules among which they are distributed, as well as by the fluid with which they are surrounded. When advanced far in its pregnancy, it is scarcely possible to touch the abdomen without causing the immediate exclusion of some of the young, which are instantly capable of swimming with great alertness. The B. viviparus is a littoral fish, and is found about the coasts of the Mediterranean, and the Baltic and Northern Seas, and sometimes it enters the mouths of rivers. It feeds on the smaller fishes, &c. It is taken by the line and net; but is not estimated as food, as its bones acquire a greenish colour by boiling. See Plate II. Pisces, fig. 2.

BLIGHT, in agriculture, a general name for various distempers incident to corn and fruit trees. It affects them variously, the whole plant sometimes perishing by it, and sometimes only the leaves and blossoms, which will be scorched and shrivelled up, the rest remaining green and flourishing. Some have supposed that blights are produced by easterly winds, which bring vast quantities of insects' eggs along with them from distant places. These being lodged upon the surface of the leaves and flowers of fruit-trees cause them to shrivel up and perish. Mr. Knight, however, observes that blights are produced by a variety of causes, by insects, by an excess of heat or cold, of drought or moisture; for these necessarily derange and destroy the delicate organization of the blossoms.

The term blight is very frequently used by the gardener and farmer without any definite idea being annexed to it. If the leaves of their trees be eaten by the caterpillar, or contracted by the aphis; if the blossoms fall from the ravages of insects, or without any apparent cause, the trees are equally blighted; and if an east wind happen to have blown, the insects, or at least their eggs, whatever be their size, are supposed to have been brought by it. The true cause of blight seems to be, continued dry easterly winds for several days together, without the intervention of showers or any morning dew, by which the perspiration in the tender blossom is stopped: and if it so happen that there is a long continuance of the same weather, it equally affects the tender leaves, whereby their colour is changed, and they wither and decay.

The best remedy, perhaps, is gently to wash and sprinkle over the tree, &c. from time to time, with common water; and if the young shoots seem to be much infected, let them be washed with a woollen cloth, so as to clear them, if possible, from this glutinous matter, that their respiration and perspiration may not be obstructed. This operation ought to be performed early in the day, that the moisture may be exhaled before the cold of the night comes on; nor should it be done when the sun shines very hot.

Another cause of blights in the spring, is said to be sharp hoary frosts, which are often succeeded by hot sun-shine in the day-time. This is the most sudden and certain destroyer of fruit that is known. The chief remedy to be depended upon in this case is, that of protecting the fruit trees during the night-time with nets. This mode, where regularly and correctly performed, has been found highly beneficial.

What is termed the blight is frequently, however, no more than a debility or distemper in trees. Mr. Forsyth observes, that "this is the case when trees against the same wall, and enjoying the same advantages in every respect, differ greatly in their health and vigour, the weak ones appearing to be continually blighted, while the others remain in a flourishing condition. This very great difference, in such circumstances, can be attributed only to the different constitutions of the tress, proceeding from want of proper nourishment, or from some bad qualities in the soil; some distemper in the stock, buds, or scions; or from some mismanagement in the pruning, &c. all of which are productive of distempers in trees, of which they are, with difficulty, cured. If the fault be in the soil, it must," he says, "be dug out, and fresh mould put in its place; or, the trees must be taken up, and others, better adapted to the soil, planted in their room. It will be found absolutely necessary always to endeavour to suit the particular sorts of fruit to the nature of the soil; for it is in vain to expect all sorts of fruit to be good in the same soil. If the weakness of the tree proceed from an in-bred distemper, it will be adviseable to remove it at once, and after renewing the earth to plant another in its place." But if the weakness is brought on by ill management in the pruning, which is frequently the case, he would advise more attention to the method of pruning and training. Besides this, "there is another sort of blight that sometimes happens pretty late in the spring, as in April or May, which is very destructive to fruit trees in orchards and open plantations, and against which we know of no effectual remedy. This is what is called a fire-blast, which, in a few hours, hath not only destroyed the fruit and leaves, but often parts of trees; and sometimes entire trees have been killed by it." As this generally happens in close plantations, where the vapours from the earth and the prespiration from the trees are pent in for want of a free circulation of air to disperse them, it points out to us the only way yet known of guarding against this enemy to fruits; namely, to make choice of a clear healthy situation for kitchen-gardens, orchards, &c. and to plant the trees at such a distance as to give free admission to the air, that it may dispel those vapours before they are formed into such volumes as to occasion these blasts." But blasts may also be occasioned by the reflection of the sun's rays from hollow clouds, which sometimes act as burning mirrors, and occasion excessive heat. See APHIS

BLINDNESS, a total privation of sight, arising from an obstruction of the functions of the organs of sight, or from an entire deprivation of them.

This defect may arise from a variety of causes, existing either in the organ of sight, or in the circumstances necessary to produce vision. Blindness will be complete, when the light is wholly excluded; or partial, when it is admitted into the eye so imperfectly, as to convey only a confused perception of visible objects. Blindness may again be distinguished into periodical or permanent, transient or perpetual, natural or accidental, &c.; but these distinctions do not serve to communicate any idea of the causes of blindness.

We find various recompenses for blindness, or substitutes for the use of the eyes, in the wonderful sagacity of many blind persons, recited by Zahnius, in his "Oculus Artificialis," and others. In some, the defect has been supplied by a most excellent gift of remembering what they had seen; in others, by a delicate nose, or the sense of smelling; in others, by an exquisite touch or a sense of feeling, which they have had in such perfection, that, as it has been said of some, they learned to hear with their eyes; as it may be said of these, that they taught themselves to see with their hands. Some have been enabled to perform all sorts of curious and subtle works in the nicest and most dexterous manner.

Aldrovandus speaks of a sculptor who became blind at twenty years of age, and yet, ten years after, made a perfect marble statue of Cosmo II. de Medicis; and another of clay like Urban VIII.

Bartholin tells us of a blind sculptor in Denmark, who distinguished perfectly well, by mere touch, not only all kinds of wood, but all the colours; and F. Grimaldi gives an instance of the like kind; besides the blind organist, living in Paris, who is said to have done the same. The most extraordinary of all is a blind guide, who, according to the report of good writers, used to conduct the merchants through the sands and deserts of Arabia.

James Bernouilli contrived a method of teaching blind persons to write.

An instance, no less extraordinary, is mentioned by Dr. Bew, in the "Transactions of the Manchester Society." It is that of a person, whose name is John Metcalf, a native of the neighbourhood of Manchester, who became blind at so early an age as to be altogether unconscious of light and its various effects. His employment in the younger period of his life was that of a waggoner, and occasionally as a guide in intricate roads during the night, or when the common tracks were covered with snow. Afterwards he became a projector and surveyor of highways in difficult and mountainous parts; and in this capacity, with the assistance merely of a long staff, he traverses the roads, ascends precipices, explores vallies, and investigates their several extents, forms and situations, so as to answer his purpose in the best manner. His plans are designed and his estimates formed, with such ability and accuracy, that he has been employed in altering most of the roads over the peak in Derbyshire, particularly those in the vicinity of Buxton, and in constructing a new one between Wilmslow and Congleton, so as to form a communication between the great London road, without being obliged to pass over the mountain.

Although blind persons have occasion, in a variety of respects, to deplore their infelicity, their misery is in a considerable degree alleviated by advantages peculiar to themselves. They are capable of a more fixed and steady attention to the objects of their mental contemplation, than those who are distracted by the view of a variety of external scenes. Their want of sight naturally leads them to avail themselves of their other organs of corporeal sensation, and with this view to cultivate and improve them as much as possible. Accordingly, they derive relief and assistance from the quickness of their hearing, the acuteness of their smell, and the sensibility of their touch, which persons who see are apt to disregard.

Many contrivances have also been devised by the ingenious for supplying the want of sight, and for facilitating those analytical or mechanical operations, which would otherwise perplex the most vigorous mind and the most retentive memory. By means of these they have become eminent proficients in various departments of science. Indeed there are few sciences, in which, with or without mechanical helps, the blind have not distinguished themselves.

The case of Professor Saunderson at Cambridge is well known. His attainments and performances in the languages, and also as a learner and teacher in the abstract mathematics, in philosophy, and in music, have been truly astonishing; and the account of them appears to be almost incredible, if it were not amply attested and confirmed by many other instances of a similar kind, both in ancient and modern times.

Cicero mentions it as a fact scarcely credible, with respect to his master in philosophy, Diodotus, that "he exercised himself in it with greater assiduity after he became blind, and which he thought next to impossible to be performed without sight; that he professed geometry, and described his diagrams so accurately to his scholars, as to enable them to draw every line in its proper direction."

Jerome relates a more remarkable instance of Didymus in Alexandria, who "though blind from his infancy, and therefore ignorant of the letters, appeared so great a miracle to the world, as not only to learn logic, but geometry also, to perfection, which seems (he adds) the mos of any thing to require the help of sight."

Professor Saunderson, who was deprived of his sight by the small pox, when he was only twelve months old, seems to have acquired most of his ideas by the sense of feeling; and though he could not distinguish colours by that sense, which, after repeated trials, he said was pretending to impossibilities, yet he was able, with the greatest exactness, to discriminate the minutest difference of rough and smooth in a surface, or the least defect of polish. In a set of Roman medals, he could distinguish the genuine from the false, though they had been counterfeited in such a manner as to deceive a connoisseur, who judged of them by the eye. His sense of feeling was so acute, that he could perceive the least variation in the state of the air; and, it is said, that in a garden where observations were made on the sun, he took notice of every cloud that interrupted the observation, almost as justly as those who could see it. He could tell when any thing was held near his face, or when he passed by a tree at no great distance, provided the air was calm, and there was little or no wind: this he did by the different pulse of air upon his face. He possessed a sensibility of hearing to such a degree, that he could distinguish even the fifth part of a note; and, by the quickness of this sense, he not only discriminated persons with whom he had once conversed so long as to fix in his memory the sound of their voice, but he could judge of the size of a room into which he was introduced, and of his distance from the wall; and if he had ever walked over a pavement in courts, piazzas, &c. which reflected a sound, and was afterwards conducted thither again, he could exactly tell in what part of the walk he was placed, merely by the note which it sounded.

Sculpture and painting are arts, which, one would imagine, are of very difficult and almost impracticable attainment to blind persons, and yet instances occur, which shew, that they are not excluded from the pleasing, creative, and extensive regions of fancy.

De Piles mentions a blind sculptor, who thus took the likeness of the Duke de Bracciano in a dark cellar, and made a marble statue of King Charles I. with great justness and elegance.

However unaccountable it may appear to the abstract philosophers, yet nothing is more certain in fact, than that a blind man may, by the inspiration of the Muses, or rather by the efforts of a cultivated genius, exhibit in poetry the most natural images and animated descriptions even of visible objects, without deservedly incurring the charge of plagiarism. We need not recur to Homer and Milton for attestations to this fact: they had probably been long acquainted with the visible world before they had lost their sight, and their descriptions might be animated with all the rapture and enthusiasm which originally fired their bosoms, when the grand and delightful objects delineated by them were immediately beheld. We are furnished with instances, in which a similar energy and transport of description, at least in a very considerable degree, have been exhibited by those, on whose minds visible objects were never impressed, or have been entirely obliterated.

Dr. Blacklock affords a surprising instance of this kind, who, though he had lost his sight before he was six months old, not only made himself master of various languages, Greek, Latin, Italian, French; but acquired the reputation of an excellent poet, whose performances abound with appropriate images and animated descriptions.

Another instance, which deserves being recorded, is that of Dr Henry Moyes, in our own country, who, though blind from his infancy, by the ardour and assiduity of his application, and by the energy of native genius, not only made incredible advances in mechanical operations, in music, and in the languages; but acquired an extensive acquaintance with geometry, optics, algebra, astronomy, chemistry, and all other branches of natural philosophy.

From the account of Dr. Moyes, who occasionally read lectures on philosophical chemistry at Manchester, delivered to the Manchester society by Dr. Bew, it appears, that mechanical exercises were the favourite employment of his infant years: and that at a very early age he was so well acquainted with the use of edge tools as to be able to construct little wind-mills, and even a loom. By the sound, and the different voices of the persons that were present, he was directed in his judgment of the dimensions of the room in which they were assembled; and in this respect he determined with such a degree of accuracy, as seldom to be mistaken. His memory was singularly retentive; so that he was capable of recognizing a person on his first speaking, though he had not been in company with him for two years. He determined with surprising exactness the stature of those with whom he conversed, by the direction of their voices; and he made tolerable conjectures concerning their dispositions, by the manner in which they conducted their conversation. His eyes, though he never recollected his having seen, were not totally insensible to intense light: but the rays refracted through a prism, when sufficiently vivid, produced distinguishable effects upon them. The red produced a disagreeable sensation, which he compared to the touch of a saw. As the colours declined in violence, the harshness lessened, until the green afforded a sensation that was highly pleasing to him, and which he described as conveying an idea similar to that which he gained by running his head over smooth polished surfaces. Such surfaces, meandering streams, and gentle declivities, were the figures by which he expressed his ideas of beauty; rugged rocks, irregular points, and boisterous elements, furnished him with expressions for terror and disgust. He excelled in the charms of conversation; was happy in his allusions to visual objects; and discoursed on the nature, composition, and beauty of colours, with pertinence and precision.

This instance, and some others which have occurred, seem to furnish a presumption, that the feeling or touch of blind persons may be so improved, as to enable them to perceive that texture and disposition of coloured surfaces by which some rays of light are reflected, and others absorbed, and in this manner to distinguish colours.

It redounds very much to the honour of modern times, that the public attention has been directed to the improvement of the condition of blind persons; and that institutions have been formed in different countries for providing them with suitable employment, tending not only to alleviate their calamity, but to render them useful. The first regular and systematic plan for this purpose was proposed by M. Hally, in an "Essay on the Education of the blind," printed at Paris in the year 1786, under the patronage of the Academy of Sciences. An English translation of this essay is annexed to "Dr. Blacklock's Poems," printed at Edinburgh in 1793, 4to. The object of this plan is to teach the blind reading, by the assistance of books, in which the letters are rendered palpable by their elevation above the surface of the paper; and by these means to instruct them, not only in the liberal arts and sciences, but likewise in the principles of mechanical operations, such as spinning, knitting, bookbinding, &c. so that those who are in easy circumstances may be capable of amusing employment, and those of the lower ranks of life, and such as have no genius for literary improvement, may, nevertheless become respectable, useful, and independent members of society, in the situation of common artisans. By these palpable characters, they are taught to read, to write, and to print; and they are likewise instructed according to their several talents and stations, in geometry, algebra, geography, and every branch of natural philosophy. The institution encourages and cherishes a taste for the fine arts; it teaches the blind to read music with their fingers, as others do with their eyes; and it does this with so much success, that though they cannot at once feel the notes and perform them upon an instrument, yet they are capable of acquiring any lesson with as much exactness and rapidity, as those who enjoy all the advantages of sight.

We are happy to add, that institutions of a similar kind have been established in our own country; and to render our particular tribute of respect to the founders and supporters of the school for the indigent blind, instituted in London, 1799. The object, with a view to which this school was founded, is unquestionably one of the most important and interesting kind that can excite compassion, or demand encouragement. It provides instruction for the indigent blind, in a trade by which they may be able to provide, either wholly or in part, for their own subsistence; and thus, instead of being altogether a burden to the community, they will be of some service to it; and instead of being depressed and cheerless themselves, under a sense of their total dependence, and for want of regular employment, habits of industry will relieve their spirits, and produce the most beneficial effects on their state and character. The children of this institution are completely clothed, boarded, lodged, and instructed, gratis. The articles at present manufactured in the school are, shoemaker's thread, fine and coarse thread, window sash-line, and clothes-line (of a peculiar construction, and made on a machine adapted to the use of blind persons) by the females; and window and sash-line, clothes-line, hampers, and wicker-baskets, by the males.

The success that has crowned the efforts of the friends of this institution, since its first establishment, affords sufficient evidence of the degree in which the situation and faculties of the blind are capable of improvement; and a view of it in its present prosperous state must be gratifying to persons of humane and compassionate feelings. Here they will not find the scholars sitting in listless indolence, which is commonly the case with the blind, or brooding in silence over their own defects, and their inferiority to the rest of mankind; but they will behold a number of individuals, of a class hitherto considered as doomed to a life of sorrow and discontent, and to be provided for merely in alms-houses, or by donations of charity, not less animated in their amusements, during the hours of recreation, and far more cheerfully attentive to their work in those of employment, than persons possessed of sight.

To this article we shall subjoin the following directions, given by Mr. Thicknesse, for teaching the blind to write. "Let any common joiner make a flat board, about 14 inches long and 12 wide, in the middle of which let a place be sunk, deep enough, when lined with cloth, to hold only two or three sheets of fool's-cap paper, which must quite fill up the space: over this must be fixed a very thin false frame, which is to cover all but the paper, and fastened on by four little pins, fixed in the lower board, and across the lower frame: just over the paper must be a little slider, an inch and a half broad, to slip down into several recesses made in the upper frame, at a proper distance for the lines, which should be near an inch asunder; and this ruler, on which the writer is to rest his fourth and little finger, must be made full of little notches, at a quarter of an inch distant from each other; and these notches will inform the writer, by his little finger dropping from notch to notch, how to avoid running one letter into another. When he comes to the end of the line, he must move his slider down to the next groove, which may be easily so contrived with a spring, to give warning that it is properly removed to the second line, and so on."

BLINDS, or **Blindes**, in the art of war, a sort of defence commonly made of oziers, or branches interwoven, and laid across between two rows of stakes, about the height of a man, and four or five feet asunder, used particularly at the heads of trenches, when they are extended in front towards the glacis; serving to shelter the workmen, and prevent their being overlooked by the enemy.

BLINK, of the ice, in sea language, that dazzling whiteness about the horizon, which is occasioned by the reflection of light from the fields of ice.

BLISTER, in medicine, a thin bladder containing a watery humour, whether occasioned by burns and the like accidents, or by vesicatories laid on different parts of the body for that purpose.

BLITUM, in botany, a genus of the Monandria Digynia class and order. Natural order of Holoraceæ; Atriplices, Jussieu. Essential character: calyx trifid; petal none; seed one, with a berried calyx. There are four species, of which B. capitatum is an annual plant, with leaves somewhat like those of spinach; the stalk rises about two feet and a half high in gardens; the upper part of it has flowers coming out in small heads at every joint, and is terminated by a small cluster of the same. After the flowers are past, these little heads swell to the size of wood strawberries, and, when ripe, have the same appearance, being very succulent and full of a purple juice, which stains the hands. It is commonly called strawberry blite, strawberry spinach, or bloody spinach; by some, berry-bearing orach. Native of Switzerland, the Grisons, Austria, the Tyrol, Spain, and Portugal.

B. virgatum, seldom grows more than one foot high, with smaller leaves than the capitatum, but of the same shape. The flowers are small, and collected into little heads, shaped like those of the first, but smaller, and not so deeply coloured. A native of the South of France, Spain, Italy, and Tartary. Of the other species, the one rises more than three feet high: the other is a very low plant, and is found in Tartary and Sweden.

BLOCKS, on ship-board, is the usual name for what we call pullies at land. They are thick pieces of wood, some with three, four, or five shivers in them, through which all the running ropes run. Blocks, whether single or double, are distinguished and called by the names of the ropes they carry, and the uses they serve for.

Double blocks are used when there is occasion for much strength, because they will purchase with more ease than single blocks, though much slower.

Block and block, is a phrase signifying that two blocks meet, in haling any tackle or halliard, having such blocks belonging to them.

The blocks now used in the navy are made in Portsmouth by means of circular saws and other machinery, which have been lately erected by a most ingenious mechanician. This machinery performs the several operations, from the rough timber to the perfect block, in the completest manner possible. The whole is worked by means of a steam-engine; the manual labour required is simply to supply the wood as it is wanted to the several parts of the machinery, so that the commonest labourer almost may be made to act in this business with very little instruction.

Fish block is hung in a notch at the end of the davit; it serves to hale up the flooks of the anchor at the ship's bow.

Snatch block is a great block with a shiver in it, and a notch cut through one of its cheeks, for the more ready receiving of any rope; as by this notch the middle part of a rope may be reeved into the block without passing it endwise. It is commonly fastened with a strap about the main mast, close to the upper deck, and is chiefly used for the fall of the winding tackle, which is reeved into this block, and then brought to the capstan.

BLOCK *house*, a kind of wooden fort or battery, either mounted on rollers, or on a vessel, and serving either on the water or in counterscarps and counter approaches. The name is sometimes also given to a brick or stone fort built on a bridge, or the brink of a river, serving not only for its defence, but for the command of the river both above and below: such was that noted block-house anciently on the bridge of Dresden, since demolished on enlarging the bridge.

BLOCKADE, in the art of war, the blocking up a place by posting troops at all the avenues leading to it, to keep supplies of men and provisions from getting into it; and by these means proposing to starve it out without making any regular attacks.

To raise a blockade, is to force the troops that keep the place blocked up from their posts.

BLOOD is a well known fluid, which circulates in the veins and arteries of the more perfect animals. It is of a red colour, has a considerable degree of consistency, and an unctuous feel, as if it contained a quantity of soap. Its taste is slightly saline, and it has a peculiar smell. The specific gravity of human blood is, at a medium, 1.05. Mr. Fourcroy found the specific gravity of bullock's blood, at the temperature of 60°, to be 1.056. The blood does not uniformly retain the same consistence in the same animal, and its consistence in different animals is very various. It is easy to see that its specific gravity must be equally various. When blood, after being drawn from an animal, is allowed to remain for some time at rest, it very soon coagulates into a solid mass, of the consistence of curdled milk. This mass gradually separates into two parts, one of which is fluid, and is called serum; the other, the coagulum, has been called cruor, because it alone retains the red colour which distinguishes blood. This separation is very similar to the separation of curdled milk into curds and whey. The proportion between the cruor and serum of the blood varies much in different animals, and even in the same animal in different circumstances. The most common proportion is about one part of cruor to three parts of serum. 1. The serum is of a light greenish yellow colour: it has the taste, smell, and feel of the blood, but its consistence is not so great. It converts syrup of violets to a green, and therefore contains an alkali. On examination, Roulle found that it owes this property to a portion of soda. When heated to the temperature of 156°, the serum coagulates. It coagulates also when boiling water is mixed with it, but if serum be mixed with six parts of cold water, it does not coagulate by heat. When coagulated, it has a greenish white colour, and is not unlike the boiled white of an egg. If the coagulum be cut into small pieces, a muddy fluid may be squeezed from it, which has been termed the serosity. After the separation of this fluid, if the residuum be carefully washed in boiling water and examined, it will be found to possess all the properties of coagulated albumen. The serum, therefore, contains a considerable proportion of albumen. Hence its coagulation by heat, and the other phenomena which albumen usually exhibits. If serum be diluted with six times its weight of water, and then boiled to coagulate the albumen, the liquid which remains after the separation of the coagulum, if it be gently evaporated till it becomes concentrated, and then be allowed to cool, assumes the form of a jelly. Consequently it contains gelatine. If the coagulated serum be heated in a silver vessel, the surface of the silver becomes black, being converted into a sulphuret. Hence it is evident that it contains sulphur: and Proust has ascertained that it is combined with ammonia in the state of a hydrosulphuret. If serum be mixed with twice its weight of water, and, after coagulation by heat, the albumen be separated by filtration, and the liquid be slowly evaporated till it is considerably concentrated, a number of crystals are deposited when the liquid is left standing in a cool place. These crystals consist of carbonate of soda, muriate of soda, besides phosphate of soda and phosphate of lime. The soda exists in the blood in a caustic state, and seems to be combined with the gelatine and albumen. The carbonic acid combines with it during evaporation. Thus it appears that the serum of the blood contains albumen, gelatine, hydrosulphuret of ammonia, soda, muriate of soda, phosphate of soda, and phosphate of lime. These component parts account for the coagulation occasioned in the serum by acids and alcohol, and the precipitation produced by tannin, acetate of lead, and other metallic salts. The cruor, or clot, as it is sometimes called, is of a red colour, and possesses considerable consistence. Its mean specific gravity is about 1.245. If this cruor be washed carefully by letting a small jet of water fall upon it, till the water runs off colourless, it is partly dissolved, and partly remains upon the searce. Thus it is separated into two portions: namely, 1. A white, solid, elastic substance, which has all the properties of fibrin; 2. The portion held in solution by the water, which consists of the colouring matter, not, however, in a state of purity, for it is impossible to separate the cruor completely from the serum. We are indebted to Bucquet for the first precise set of experiments on this last watery solution. It is of a red colour. Bucquet proved that it contained albumen and iron. Menghini had ascertained, that if blood be evaporated to dryness by a gentle heat, a quantity of iron may be separated from it by the magnet. The quantity which he obtained was considerable; according to him the blood of a healthy man contains above two ounces of it. Now, as neither the serum nor the fibrin extracted from the cruor contains iron, it follows of course, that the water holding the colouring matter in solution must contain the whole of that metal. This watery solution gives a green colour to syrup of violets. When exposed to the air, it gradually deposits flakes, which have the properties of albumen. When heated, a brown coloured scum gathers on its surface. If it be evaporated to dryness, and then mixed with alcohol, a portion is dissolved, and the alcoholic solution yields, by evaporation, a residuum, which lathers like soap in water, and tinges vegetable blues green: the acids occasion a precipitate from its solution. This substance is a compound of albumen and soda. Thus we see that the watery solution contains albumen, iron, and soda. When new-drawn blood is stirred briskly round with a stick, or the hand, the whole of the fibrin collects together upon the stick, and in this manner may be separated altogether from the rest of the blood. The red globules, in this case, remain behind in the serum. It is in this manner that the blood is prepared for the different purposes to which it is put; as clarifying sugar, making puddings, &c. After the fibrin is thus separated, the blood no longer coagulates when allowed to remain at rest, but a spongy, flaky matter separates from it and swims on the surface.

BLUE, otherwise called azure, is one of the primitive colours of the rays of light.

Blue, *painters*, is made different, according to the different kinds of painting.

In limning, fresco, and miniature, they use indifferently ultramarine, blue ashes, and smalt: these are their natural blues, excepting the last, which is partly natural and partly artificial.

In oil and miniature they also use indigo prepared; as also a fictitious ultramarine.

Enamellers and painters upon glass have blues proper to themselves, each preparing them after their own manner.

BLUING *of iron*, a method of beautifying that metal sometimes practised; as for mourning buckles, swords, or the like. The manner is thus: take a piece of grindstone and whetstone, and rub hard on the work, to take off the black scurf from it; then heat it in the fire, and as it grows hot the colour changes by degrees, coming first to a light, then to a dark gold colour, and lastly to a blue. Sometimes they grind also indigo and sallad oil together, and rub the mixture on the work with a woollen rag while it is heating, leaving it to cool of itself. Among sculptors we also find mention of bluing a figure of bronze, by which is meant the heating of it to prepare it for the application of gold leaf, because of the bluish cast it acquires in the operation.

BLUENESS, that quality which denominates a body blue, depending on such a size and texture of the parts that compose the surface of a body, as dispose them to reflect the blue or azure rays of light, and those only, to the eye.

With respect to the blueness of the sky, M. de la Hire, after Leonardo da Vinci, observes, that any black body, viewed through a thin white one, gives the sensation of blue; and this he assigns as the reason of the blueness of the sky, the immense depth of which, being wholly devoid of light, is viewed through the air, illuminated and whitened by the sun. For the same reason, he adds, it is, that soot mixed with white makes a blue; for white bodies, being always a little transparent, and mixing themselves with a black behind, give the perception of blue. From the same principle he accounts for the blueness of the veins on the surface of the skin, though the blood they are filled with be a deep red; for red, he observes, unless viewed in a clear, strong light, appears a dark brown, bordering on black: being then in a kind of obscurity in the veins, it must have the effect of a black; and this, viewed through the membrane of the vein and the white skin, will produce the perception of blueness.

In the same way did many of the early writers account for the phenomenon of a blue sky; but, in the explanation of this phenomenon, Sir Isaac Newton observes, that all the vapours, when they begin to condense and coalesce into natural particles, become first of such a bigness as to reflect the azure rays, before they can constitute clouds of any other colour. This, therefore, being the first colour which they begin to reflect, must be that of the finest and most transparent skies, in which the vapours are not arrived to a grossness sufficient to reflect other colours.

M. Bouguer, without having recourse to the vapours diffused through the atmosphere, in order to account for the reflection of the blue-making rays, ascribes it to the constitution of the air itself, whereby these fainter coloured rays are incapable of making their way through any considerable tract of it: and he accounts for those blue shadows, which were first observed by M. Buffon in the year 1742, by the aërial colour of the atmosphere, which enlightens these shadows, and in which the blue rays prevail; whilst the red rays are not reflected so soon, but pass on to the remoter regions of the atmosphere.

The Abbé Mazeas, in a Memoir of the Society in Berlin, for the year 1752, accounts for the phenomenon of blue shadows, by the diminution of light; having observed, that of two shadows which were cast upon a white wall, from an opaque body illuminated by the moon, and by a candle at the same time, that which was enlightened by the candle was reddish, and that which was enlightened by the moon was blue. However, the true cause of this appearance seems to be that assigned by M. Bouguer, which agrees with the solution given of it about the same time by Mr. Melville. But, instead of attributing the different colours of the clouds, as Sir Isaac Newton does, to the different size of those globules into which the vapours are condensed, Mr. Melville supposes, that the clouds only reflect and transmit the sun's light; and that, according to their different altitudes, they may assume all the variety of colours at sun-rising and setting, by barely reflecting the sun's incident light, as they receive it through a shorter or longer tract of air; and the change produced in the sun's rays by the quantity of air through which they pass, from white to yellow, from yellow to orange, and lastly to red, may be understood agreeably to this hypothesis, by applying to the atmosphere what Sir Isaac Newton says concerning the colour of transparent liquors in general, and that in the infusion of lignum nephriticum in particular.

BLUSHING, a suffusion or redness of the cheeks, excited by a sense of shame on account of a consciousness of some failing or imperfection.

Blushing is supposed to be produced from a kind of consent or sympathy between the several parts of the body, occasioned by the same nerve being extended to them all. Thus, the fifth pair of nerves being branched from the brain to the eye, ear, muscles of the lips, cheeks and palate, tongue and nose, a thing seen or heard, that is shameful, affects the cheeks with blushes, driving the blood into their minute vessels at the same time that it affects the eye and ear. Mr. Derham farther observes, upon this subject, that a savory thing seen or smelt affects the glands and parts of the mouth; if a thing heard be pleasing, it affects the muscles of the face with laughter; if melancholy, it exerts itself on the glands of the eyes, and occasions weeping, &c. To the same cause is, by others, the pleasure of kissing ascribed.

B MI, in music, the third note in the modern scale.

B MOLLARE, or Molle, one of the notes of the scale of music, usually called soft or flat, in opposition to b quadro.

BOA, in natural history, a genus of serpents, of which the generic character is, plates on the belly and under the tail, without a rattle. Gmelin mentions ten species only, but Dr. Shaw and others enumerate as many as eighteen. B. contortrix is found in Carolina, and has about 150 plates on the belly, and 40 on the tail; it is broad, with a convex back; colour cinereous, with lateral round spots; has a poisonous bag, but no fangs; tail from one third to a half the length of the whole body: it is very slow in its motions. B. constrictor is very remarkable for its vast size, some of the principal species which are met with in India, Africa, and South America, have been seen between 30 and 40 feet long, and possessed of so much strength as to be able to kill cattle, by twisting around them and crushing them to death by pressure, after which they devour them, eating till they are almost unable to move; in that state they may be easily shot. Dr. Shaw observes, that these gigantic serpents are become less common, in proportion to the increased population of the parts where they are found; they are, however, still to be seen, and will approach the abodes in the vicinity of their residence. This species is beautifully variegated with rhombic spots; belly whitish; is of vast strength and size, measuring 30 and 36 feet long. With respect to age, sex, and climate, it is subject to considerable variations. It is supposed that an individual of this species once diffused terror and dismay in a whole Roman army, a fact alluded to by Livy in one of the books that have not come to us, but which is quoted by Valerius Maximus, in words to the following effect: "Since we are on the subject of uncommon phenomena, we may here mention the serpent so eloquently recorded by Livy, who says that near the river Bagrada in Africa, a snake was seen of so enormous a magnitude, as to prevent the army of Attilius Regulus from the use of the river; and after snatching up several soldiers with its enormous mouth, and devouring them, and killing several more by striking and squeezing them with the spires of its tail, was at length destroyed, by assailing it with all the force of military engines and showers of stones, after it had withstood the attack of their spears and darts; that it was regarded by the whole army as a more formidable enemy than even Carthage itself; and that the whole adjacent region being tainted with the pestilential effluvia proceeding from its remains, and the waters with its blood, the Roman army was obliged to remove its station. The skin of the monster was 120 feet long, and was sent to Rome as a trophy."

Another account says, that "it caused so much trouble to Regulus, that he found it necessary to contest the possession of the river with it, by employing the whole force of the army, during which a considerable number of soldiers were lost, while the serpent could neither be vanquished nor wounded, the strong armour of its scales easily repelling the force of all the weapons that were directed against it: upon which recourse was had to battering engines, with which the animal was attacked in the manner of a fortified tower, and was thus at length overpowered. Several discharges were made against it without success, till its back being broken by an immense stone, the monster began to lose its powers, and was with difficulty destroyed, after having diffused such a horror among the army, that they confessed they would rather attack Carthage itself than such another monster."

The flesh of the serpent is eaten by the Indians and Negroes of Africa, and they make its skin into garments.

Boa *scytale*, or *spotted*. The spotted boa is sometimes scarcely inferior in size to the constrictor, and is of similar manners, destroying, like that animal, goats, sheep, deer, &c. It is described as being generally of a grey or glaucous colour, marked with large orbicular black spots on the back, and with smaller ones of similar form, but with white centres, on the sides; while on the abdomen are scattered several oblong spots and marks, interspersed with smaller specks and variegations. It is a native of several parts of South America. And, like other large snakes, is occasionally eaten by the Indians.

Boa *canina*, a highly beautiful snake, measuring about four feet in length, and being of moderate size or thickness in proportion: the head is large, and shaped like that of a dog; the colour of the whole animal on the upper parts is a most beautiful Saxon-green, with several short undulating, transverse white bars down the back, the edges of which are of a deeper or stronger green than the ground colour of the body: the under or abdominal part is white. This species is a native of South America. In the British Museum is an elegant specimen. See Plate Serpentes, fig. 3.

Boa *phrygia*. Among the whole serpent tribe, it may be doubted whether there exists a species more truly elegant than the present. Its general size seems to be nearly that of the boa canina, but its length is rather greater in proportion: the ground colour of the whole animal is white, with a very slight cast of yellowish brown on the back, while along the whole upper part is disposed a continued series of black variegations, so conducted as to bear a striking resemblance to an embroidery in needle-work: the head is of the same form with that of the boa canina, and marked by three narrow black streaks, which, running along the top of the head and the cheeks, join with the embroidered pattern of the back.

Boa *hortulana*, is of a moderate size, measuring only a few feet in length, and being of a slender form; has obtained its Linnæan title from the singular variegations on the head, which are of a blackish brown, on a pale ferruginous or yellowish ground, and in some degree represent the form of a parterre in an old-fashioned garden: the variegations on the body are of similar colour, and are disposed into large circular, and sometimes angular, patches on the sides.

Boa *fasciata*. It is to Dr. Patrick Russel that we owe the knowledge of this remarkable species, which is a native of India, and is said to be most frequent in the country of Bengal. It is of a yellow colour, marked with pretty numerous dusky blue transverse bands, continued at equal distances: the head is rather small, and covered in front with large scales: the body is of a trigonal form, the sides sloping very considerably; the whole length of the animal is something more than five feet; the diameter, in the thickest part, being nearly five inches; the length of the tail five inches only, and its termination rather obtuse. This snake is among the number of poisonous species; and its bite is considered by the Indians as inevitably fatal. A specimen was brought to Dr. Russel in the month of November, 1788, in an apparently weak and languid state, having been bruised in taking. Being set at liberty in a room, it crept slowly towards an obscure corner, where a chicken being presented to him, he took no particular notice of it, and even suffered the bird to stand on his back. As he shewed no disposition to bite, his jaws were forcibly opened, and the thigh of the chicken being placed between them, the mouth was so closed over it as to oblige the fangs to act. The bird, when disengaged, shewed immediately symptoms of poison; and after several ineffectual efforts to rise, rested with the beak on the ground, the head being seized with trembling. In the space of 20 minutes it lay down on one side, and convulsions soon supervening, it expired within 26 minutes from the bite.

BOAR. See Sus.

BOARD, among seamen. To go aboard, signifies to go into the ship. To slip by the board, is to slip down by the ship's side. Board and board, is when two ships come so near as to touch one another, or when they lie side by side. To make a board is to turn to windward; and the longer your boards are, the more you work into the wind. To board it up, is to beat it up sometimes upon one tack, and sometimes upon another She makes a good board, that is, the ship advances much at one tack. The weather board, is that side of the ship which is to windward.

BOARDING a ship, is entering an enemy's ship in a fight. In boarding a ship, it is best to bear up directly with him, and to cause all your ports to leeward to be beat open; then bring as many guns from your weather side, as you have ports for; and laying the enemy's ship on board, loof for loof, order your tops and yards to be manned, and furnished with necessaries; and let all your small shot be in readiness; then charge at once, with both small and great, and at the same time, enter your men under cover of the smoke, either on the bow of your enemy's ship, or bring your midship close up with her quarter, and so enter your men by the shrouds: or if you would use your ordnance, it is best to board your enemy's ship athwart her hawse; for, in that case, you may use most of your great guns, and she only those of her prow. Let some of your men endeavour to cut down the enemy's yards and tackle, whilst others clear the decks, and beat the enemy from aloft. Then let the scuttles and hatches be broke open with all possible speed, to avoid trains, and the danger of being blown up by barrels of powder placed under the decks.

Another method is described in Falconer's Marine Dictionary, which is as follows: the assailant having previously selected his men, armed with pistols and cutlasses, a number of powder flasks, fitted with fuzes, are provided, to be thrown upon the enemy's deck immediately before the assault. Besides this, the boarder is generally furnished with an earthen shell, called a stink-pot, which, on that occasion, is suspended from his yard-arms or bowsprit end. This machine is also charged with powder, mixed with other inflammable and suffocating materials, with a lighted fuze at the aperture. Thus prepared, and having grappled his adversary, the boarder displays his signal to begin the assault. The fuzes of the stink-pot and powder-flasks being lighted, they are immediately thrown upon the deck of the enemy, where they burst and catch fire, producing an intolerable stench and smoke, and filling the deck with tumult and distraction. Amidst the confusion occasioned by this infernal apparatus, the detachment provided rush aboard, sword in hand, under cover of the smoke, on their antagonist, who is in the same predicament with a citadel stormed by besiegers, and generally overpowered, unless he is furnished with extraordinary means of defence, or equipped with places of retreat, furnished with small arms, &c. which may be fired at any time upon the boarders, and frequently with success.

BOAT, is a small open vessel worked by oars or sails. The construction and names of boats are different, according to the purposes for which they are intended. The boats or wherries plying on the Thames about London are either scullers, wrought by a single person, with oars; or oars, wrought by two persons, each with an oar.

Boat, *life*, a boat invented by Mr. Henry Greathead, of South Shields, for the purpose of preserving the lives of shipwrecked persons.

In the year 1802, the Society of Arts rewarded the inventor with their gold medal and fifty guineas for his invention. The length of the boat is 30 feet, and both ends are made exactly similar, so that she may be rowed in either direction; and she is steered by an oar at each end, in the place of a rudder. These oars are one-third longer than the rowing oars, and afford a great power to set the boat straight, to meet the waves in a proper manner; she is generally rowed by ten oars, and will carry a great number of passengers, though she should be full of water. This is owing to a considerable quantity of cork made fast to her gunwale, which at the same time renders her very buoyant, and guards her against being stoved by running foul of a ship's side, &c. The particular construction of this boat will be best understood by referring to Plate Life Boat, &c. in which

Fig. 1. *A cross section of the Life boat.*

F, F. The outside coatings of cork.
G, G. The inside cork filling.
H, H. The outside planks of the boat.
I. One of the stems of the boat.
K. The keel.
N, N. The timber-heads.
P. The thwarts, or rowers' seats.
R. One of the stanchions under the thwarts, each being thus firmly supported.
S. A section of the gang-board, which crosses the thwarts, and forms the passage from one end of the boat to the other.
T. The floor-heads, or platform for the rowers' feet.
V, V. The two bilge pieces nearly level with the keel.
W, W. The gunwales.
X. A ring bolt for the head-fast, there being another also at the other end.
Y. Platform for the steersman.

Fig. 2. *A longitudinal section of the Life Boat.*

E, E, E. The sheer or curve of the boat.
I, I. The two sterns or ends.
K. The keel.
L, L. The aprons, to strengthen the stems.
M, M. The sheets, or place for passengers.
N, N. Timber heads, or boat-fastenings.
O, O, O, O. The tholes on which the oars are slung by gromets.
T. Flooring under the rowers' feet.

Fig. 3. *Plan of a Truck or Carriage with four wheels, to convey the boat to and from the sea.*

a. An oblong frame of wood consisting of two long pieces, hollowed a little to admit the body of the boat, and secured by the cross pieces, *b*, *b*.

c, *c*, *c*, *c*. Four low wheels, each sunk or hollowed in the middle, to run better upon a rail-way or timber-road.

d, *d*. Two indents made in the side timbers, that the bottom of the boat may be firm therein.

e, *e*. Two small rollers moveable in the cross timbers, for the keel of the boat to slide upon.

f, *f*. Two long rollers, one at each end of the frame to assist in raising the boat upon, or sliding it off the truck or carriage.

This boat went off on the 30th of January, 1790; and so well has it answered, and even exceeded, every expectation, in the most tremendous sea, that, during the last eighteen years, not fewer than between two and three hundred lives have been saved at the entrance of the Tyne alone, which otherwise must have been lost; and in no instance has it ever failed. This useful, and to a maritime nation, highly important invention, was occasioned by the following circumstance: In September, 1789, the ship Adventure, of Newcastle, was stranded on the south-side of Tynemouth Haven, in the midst of the most tremendous breakers, and all the crew dropped from the rigging one by one, in the presence of thousands of spectators, not one of whom could be prevailed upon by any reward to venture out, to her assistance, in any boat of the common construction. On this melancholy occasion the gentlemen of South Shields called a meeting of the inhabitants, and premiums were instantly offered for plans of a boat, which should be the best calculated to brave the dangers of the sea, particularly of broken water. Many persons laid claim to the reward, but the preference was given unanimously to Mr. Greathead's.

The principle of this boat appears to have been suggested to the inventor by the following simple fact: Take a spheroid, and divide it into quarters: each quarter is elliptical, and nearly resembles the half of a wooden bowl, having a curvature with projecting ends: this, thrown into the sea or broken water, cannot be upset, or lie with the bottom upwards. The length of the boat is, as we have seen, thirty feet; the breadth ten feet; the depth, from the top of the gunwale to the lower part of the keel in midships, three feet three inches; from the gunwale to the platform (within,) two feet four inches; from the top of the stems, (both ends being similar) to the horizontal line of the bottom of the keel, five feet nine inches. The keel is a plank of three inches thick, of a proportionate breadth in midships, narrowing gradually towards the ends, to the breadth of the stems at the bottom, and forming a great convexity downwards. The ends of the bottom section form that fine kind of entrance observable in the lower part of the bow of the fishing-boat called a coble, much used in the north. From this part to the top of the stem it is more elliptical, forming a considerable projection. The sides, from the floor-heads to the top of the gun-wale, flaunch off on each side, in proportion to above half the breadth of the floor. The breadth is continued far forwards towards the ends, leaving a sufficient length of straight side at the top. The sheer is regular along the straight side, and more elevated towards the ends. The gunwale fixed to the outside is three inches thick. The sides, from the under part of the gunwale, along the whole length of the regular sheer, extending twenty-one feet six inches, are cased with layers of cork, to the depth of sixteen inches downwards; and the thickness of this casing of cork being four inches, it projects at the top a little without the gunwale. The cork on the outside is secured with thin plates, or slips of copper, and the boat is fastened with copper nails. The thwarts, or seats, are five in number, double banked; consequently, the boat may be rowed with ten oars. The boat is steered with an oar at each end: and the steering oar is one third longer than the rowing oar. The platform placed at the bottom, within the boat, is horizontal, the length of the midships, and elevated at the ends, for the convenience of the steersman, to give him a greater power with the oar. The internal parts of the boat next the sides is cased with cork; the whole quantity of which affixed to the life-boat is nearly seven hundred weight. The cork, indisputably, contributes much to the buoyancy of the boat, is a good defence in going along side a vessel, and is of principal use in keeping the boat in an erect position in the sea, or, rather, for giving her a very lively and quick disposition to recover from any sudden cant or lurch, which she may receive from the stroke of a heavy wave. But, exclusively of the cork, the admirable construction of this boat gives it a decided pre-eminence. The ends being similar, the boat can be rowed either way; and this peculiarity of form alleviates her in rising over the waves. The curvature of the keel and bottom facilitates her movement in turning, and contributes to the ease of the steerage, as a single stroke of the steering oar has an immediate effect, the boat moving as it were upon a centre. The fine entrance below is of use in dividing the waves, when rowing against them; and, combined with the convexity of the bottom, and the elliptical form of the stem, admits her to rise with wonderful buoyancy in a high sea, and to launch forward with rapidity without shipping any water, when a common boat would be in danger of being filled. The internal shallowness of the boat from the gunwale down to the platform, the convexity of the form, and the bulk of cork within, leave a very diminished space for the water to occupy, so that the life-boat, when filled with water, contains a considerable less quantity than the common boat, and is in no danger either of sinking or overturning.

It may be presumed by some, that in cases of high wind, agitated sea, and broken waves, a boat of such a bulk could not prevail against them by the force of oars; but the life-boat, from her peculiar form, may be rowed a-head, when the attempt in other boats would fail. Boats of the common form, adapted for speed, are, of course, put in motion with a small power; but, for want of buoyancy and bearing, are over-run by the waves, and sunk, when impelled against them; and boats constructed for burthen meet with too much resistance from the wind and sea, when opposed to them, and cannot, in such cases, be rowed from the shore to a ship in distress.

BOATSWAIN, a ship officer, to whom is committed the charge of all the tacklings, sails, and rigging, ropes, cables, anchors, flags, pendants, &c. He is also to take care of the long-boat and its furniture, and to steer her either by himself or his mate.

He calls out the several gangs and companies aboard, to the due execution of their watches, works, spells, &c. He is likewise provost-marshal, who sees and punishes all offenders sentenced by the captain, or a court-martial of the fleet. He ought frequently to examine the condition of the masts, sails, and rigging, and remove whatever may be unfit for service, or supply what is deficient; and he is ordered by his instructions to perform his duty "with as little noise as possible."

Boatswain's *mate* has the peculiar command of the long-boat, for the setting forth of anchors, weighing or fetching home an anchor, warping, towing, or mooring; and is to give an account of his store.

BOB, a term used for the ball of a short pendulum.

Bob, in ringing of bells, denotes a peal consisting of several courses, or sets of changes.

BOBARTIA, in botany, a genus of the Triandria Digynia class of plants, the calyx of which is imbricated, and contains only a single flower; the corolla is a glume, consisting of two valves, and placed on the germen; the seed is single, of an oval figure, and is contained in the cup.

BOBBIN, a small piece of wood turned in the form of a cylinder, with a little border jutting out at each end, bored through to receive a small iron pivot. It serves to spin with the spinning-wheel, or to wind thread, worsted, hair, cotton, silk, gold, and silver.

BOBBING, among fishermen, a particular manner of catching eels different from sniggling.

BOB-STAYS, in nautical language, ropes used to confine the bowsprit downward to the stem or cut-water. A bob-stay is fixed, by thrusting one of its ends through a hole bored in the fore part of the cut-water for this purpose, then splicing both ends together, so as to make it two-fold, or like the link of a chain; a dead-eye is then seized into it, and a laniard passing through this, and communicating with another dead-eye upon the bowsprit, is drawn extremely tight by the help of mechanical powers. The use of the bob-stay is to draw down the bowsprit, and keep it steady, and to counteract the force of the stays of the foremast, which draws it upwards. The bowsprit is also fortified by shrouds from the bows on each side; on this, and other accounts, the bob-stay is the first part of a ship's rigging which is drawn tight to support the masts.

BOCARDO, among logicians, the fifth mode of the third figure of syllogisms, in which the middle proposition is an universal affirmative, and the first and last particular negatives, thus:

Bo Some sickly persons are not students:

car Every sickly person is pale:

do Therefore some persons are pale that are not students.

BOCCONIA, in botany, so called from a Sicilian monk, a genus of the Dodecandria Monogynia class and order. Natural order of Rhoeadeæ: Papaveraceæ, Jussieu. Essential character: calyx two-leaved; corolla none; style bifid; berry dry, one-seeded. There is only one species, *viz.* B. frutescens, shrubby bocconia, tree celandine, or parrot weed, is a shrub rising to the height of ten or twelve feet; with a straight trunk, as large as a man's arm, covered with a white smooth bark, and branched towards the top. The trunk is hollow, filled with a pith, like the alder, abounding in a thick yellow juice, like argemone and celandine; branches brittle, unequal, marked with scars from the fallen leaves; leaves from six or seven inches to a foot in length; filaments ten, seldom more, longer than the leaflets of the calyx, hanging down loose; anthers longer than the filaments. It is a native of the West India islands, where the juice of it is used to take off tetters and warts.

BOCK-LAND, in the Saxons' time, is what we now call freehold lands, held by the better sort of persons by charter or deed in writing, by which name it was distinguished from folkland, or copyhold land, holden by the common people without writing.

BODIANUS, in natural history, a genus of fishes of the order Thoracici, of which the generic character is, habit of the genus Perca, gill-covers scaly, serrated, and aculeated; scales generally smooth. They are divided into two classes, one with divided or forked tails: the other with even or rounded tails. Dr. Shaw, in his excellent zoology, enumerates fifteen species. The B. luteus is about fourteen inches long, and in shape like a trout; the colour is yellow, each scale being deeply edged or tipped with orange; the back is purplish rose-colour, with scales tipped with blue; tail nearly in the middle, but running into a lanceolate tip at each side. It is a native of the South American seas. B. pentacanthus, or five-spined bodian, is about 13 inches long, shape nearly as in the luteus, but rather more slender, colour beautiful deep rose, with a silvery cast on the abdomen; tail deeply forked, the upper lobe stretching beyond the lower; anterior gill-covers armed with five strong spines; it is a native of the Brasilian seas, and is very much esteemed as food. See Plate II. Pisces, fig. 3.

BODKIN, a small instrument made of steel, bone, ivory, &c. used for making holes.

BODY, in physics, an extended solid substance, of itself utterly passive and inactive, indifferent either to motion or rest; but capable of any sort of motion, and of all figures and forms.

Body, in geometry, is a figure extended in all directions, or what is usually said to consist of length, breadth, and thickness. It is usually called a solid. A solid or body is conceived to be formed by the motion of a surface; as a surface is by the motion of a line; and a line by the motion of a point. Similar bodies are in proportion to each other as the cubes of their sides. There are five bodies which are denominated regular or Platonic bodies: these have all their sides, angles, and planes, similar and equal; they are denominated the

Tetraedron	contained by	4 equilateral triangles
Hexaedron or cube		6 squares
Octaedron		8 triangles
Dodecaedron		12 pentagons
Icosaedron		20 triangles.

In the plate Miscel. II. fig. 1 to 5, we have given the figures of each, which, if drawn on pasteboard, and cut out by the bounding lines, and then the other lines being half cut through, the parts may be turned up and fastened together by strong paste, so as to form the respective body marked with the corresponding number. Fig 1 is the tetraedron: fig. 2 the hexaedron: fig. 3 the octaedron: fig. 4 the dodecaedron, and fig. 5 the icosaedron.

To find the superficies or solidity of the regular bodies.

1. Multiply the proper tabular area (taken from the following table) by the square of the linear edge of the solid, for the superficies.
2. Multiply the tabular solidity by the cube of the linear edge, for the solid content.

Table of the surfaces and solidities of the five regular bodies, the linear edge being 1.

No. of Faces	Names	Surfaces	Solidities
4	Tetraedron	1.73205	0.11785
6	Hexaedron	6.00000	1.00000
8	Octaedron	3.46410	0.47140
12	Dodecaedron	20.64573	7.66312
20	Icosaedron	8.66025	2.18169

Bodies, *descent of.* Heavy bodies, in an unresisting medium, fall with an uniformly accelerated motion; whence the spaces descended are in the duplicate ratio of the times and velocity, and increase according to the uneven numbers

1, 3, 5, &c. The times and velocities are in a subduplicate ratio of the spaces. The velocity of descending bodies is in proportion to the times from the beginning of their fall; and the spaces described by a falling body are as the squares of the times from the beginning of their fall. See Mechanics.

Body, in law. A man is said to be bound or held in body and goods; that is, he is liable to remain in prison, in default of payment.

In France, all restraints of the body for civil debts are null after four months, unless the sum exceeds two hundred livres.

A woman, though in other respects she cannot engage her person but to her husband, may be taken by the body, when she carries on a separate trade.

Body, among painters; as, to bear a body; a term signifying that the colours are of such a nature, as to be capable of being ground so fine, and mixing with the oil so entirely, as to seem only a very thick oil of the same colour.

But such colours as are said not to bear a body will readily part with the oil when laid on the work; so that when the colour shall be laid on a piece of work, there will be a separation; the colour in some parts, and the oil in others, except they are tempered extraordinarily thick.

BOEBERA, in botany, a genus of the Syngenesia Superflua class and order. Receptacle naked; down simple; calyx double, the outer many-leaved, inner eight-leaved. One species, found in Carolina and Mexico.

BOEHMERIA, in botany; so called in honour of George Rudolph Boehmer; a genus of the Monoecia Tetrandria class and order. Natural order of Scabridæ. Urticæ, Jussieu. Essential character: male, calyx four parted; corolla none; female, calyx none, but crowded scales between each; germ obovate; style single; seed single, compressed. There are five species; of which B. caudata is a shrub, growing to the height of ten or twelve feet; the leaves are very broad. It is frequent in the cooler mountains of Liguanea, in Jamaica: B. literalis is a native of Hispaniola: B. cylindrica, is an annual plant, with a lucid herbaceous stalk, dividing into several branches; the leaves have three longitudinal veins, and are placed on pretty long foot-stalks; flowers in single catkins, which are not divided. Native of North America and Jamaica.

BOERHAVIA, in botany; so called in honour of the famous Boerhaave; a genus of the Monandria Monogynia class and order. Natural order of Agregatæ; Nyctagenes, Jussieu. Essential character: calyx none; corolla one-petalled, bell-shaped, plaited; seed one, naked, inferior. There are seven species; of these B. erecta, upright flag-weed, has a stem two feet high; at each joint a pair of ovate-pointed leaves, whitish underneath; on foot-stalks an inch in length; at these joints, which are far asunder, come out also small side branches, growing erect; they, as well as the stem, are terminated by loose panicles of flesh-coloured flowers, succeeded by oblong glutinous seeds. This plant is found at La Vera Cruz, also in the Society Isles.

BOILING. When all other circumstances are the same, the evaporation of liquids increases with their temperature: and after they are heated to a certain temperature, they assume the form of elastic fluids with great rapidity. If the heat be applied to the bottom of the vessel containing the liquids, as is usually the case after the whole liquid has acquired this temperature, those particles of it which are next the bottom become an elastic fluid first: they rise up as they are formed, through the liquid, like air bubbles, and throw the whole into violent agitation. The liquid is then said to boil. Every particular liquid has a fixed point at which this boiling commences (other things being the same;) and this is called the boiling point of the liquid. Thus, water begins to boil when heated to 212°. It is remarkable, that after a liquid has begun to boil, it never becomes any hotter, however strong the fire be to which it is exposed. A strong heat indeed makes it boil more rapidly, but does not increase its temperature. This was first observed by Dr. Hooke. The following table contains the boiling point of a number of liquids.

Bodies.	Boiling point.
Ether	98°
Ammonia	140
Alcohol	176
Water	212
Muriat of lime	230
Nitric acid	248
Sulphuric acid	590
Phosphorus	554
Oil of turpentine	560
Sulphur	570
Linseed oil	600
Mercury	660

It will be seen, when we come to treat

of the melting point of solids, that it is capable of being varied considerably by altering the situation of the body. Thus, water may be cooled down considerably lower than 32° without freezing. The boiling point is still less fixed, depending entirely on the degree of pressure to which the liquid to be boiled is exposed. If we diminish the pressure, the liquid boils at a lower temperature; if we increase it, a higher temperature is necessary to produce ebullition. From the experiments of Professor Robinson, it appears that, in a vacuum, all liquids boil about 145° lower than in the open air, under a pressure of 30 inches of mercury; therefore water would boil in vacuo at 67°, and alcohol at 34°. In a Papin's digester, the temperature of water may be raised to 300°, or even 400°, without ebullition; but the instant that this great pressure is removed, the boiling commences with prodigious violence.

BOLETUS, in botany, so called from its globular form, characterized by Linnæus as a horizontal fungus; porous, or punched, with lobes underneath. In the fourteenth edition of the "Systema Naturæ," only twenty-one species are recited, eleven of which are parasitical and stemless, the rest are stipitated. From B. igniarius is prepared the amadou, commonly used on the continent for tinder, to receive the spark struck from the steel by the flint, and the agaric for stopping hæmorrhage in amputations, &c.

BOLT, among builders, an iron fastening fixed to doors and windows. They are generally distinguished into three kinds, *viz.* plate, round, and spring bolts.

Bolts, in gunnery, are of several sorts, as, 1. Transum bolts, that go between the cheeks of a gun-carriage, to strengthen the transums. 2. Prise bolts, the large knobs of iron on the cheeks of a carriage, which keep the hand-spike from sliding when it is poised up the breech of a piece. 3. Traverse bolts, the two short bolts that, being put one in each end of a mortar carriage, serve to traverse her. 4. Bracket bolts, the bolts that go through the cheeks of a mortar, and by the help of quoins keep her fixed at the given elevation. And, 5. Bed bolts, the four bolts that fasten the brackets of a mortar to the bed.

Bolts, in a ship, are iron pins, of which there are several sorts, according to their different make and uses. Such are, drive bolts, used to drive out others; ray bolts, with jags or barbs on each side to keep them from flying out of their holes; clench bolts, which are clenched with rivetting hammers; forelock bolts, which have at the end a forelock of iron driven in, to keep them from starting back; set bolts, used for forcing the planks and bringing them close together; fend or fender bolts, made with long and thick heads, and struck into the uttermost bends of the ship, to save her sides from bruises; and ring bolts, used for bringing to of the planks, and those parts whereto are fastened the breeches and tackles of the guns.

There are various inventions for driving both into ships, and others for drawing them out; we shall describe one by Mr. R. Phillips, for driving copper bolts into ships, for which he received the gold medal from the Society of Arts, &c. in the Adelphi. The instrument employed for driving the bolts consists of a hollow tube, formed from separated pieces of cast iron, which are placed upon the heads of each other, and firmly held thereto by iron circles or rings over the joints of the tube: the lowest ring is pointed, to keep the tube steady upon the wood; the bolt, being entered into the end of the hole bored in the wood of the ship, and completely covered by the iron tube, is driven forwards within the cylinder by an iron or steel punch placed against the head of the bolt, which punch is struck by a mall; and as the bolt goes farther into the wood, part of the tube is unscrewed and taken off till the bolts are driven home into its place up to the head.

The tubes are about five inches in circumference, and will admit a bolt of seven-eighths of an inch in diameter.

References to Plate, Life Boats, &c.

Fig. 4. A, the copper bolt, with one end entered into the wood previous to fixing the tube.

B, a piece of timber or ship's side, into which the bolt is intended to be driven.

Fig. 5. C, C, C, C, the parts of the iron tube fastened together, ready to be put on the bolt A.

D, D, D, D, iron or brass rings, with thumb screws placed over the joints of the tube, to hold them firm together.

E, E, E, E, the thumb screws, which keep the rings and tube firm in their proper places.

F, two points formed on the lower ring; they are to stick into the timber, and to enable the tube to be held firm in its place.

Fig. 6. Shews the separation of the parts of the tube, which is effected by slackening the thumb screws and rings.

To put them together, you slide the rings over the joints placed as close as possible, then by tightening the thumb screws you will have them firm together, and may continue the tube to any length, from one foot to whatever number is required.

Fig. 7. G, H, two steel punches or drifts, to be placed on the head of the copper bolt within the tube whilst driving. The blow given upon the punch drives forward the bolt. The shortest of them should be used first, and when driven nearly to its head should be taken out of the tube, and the longer punch applied in its place.

BOLTONIA, in botany, so called in honour of Mr. James Bolton of Halifax, a genus of the Syngenesia Polygamia Superflua. Natural order of Compositæ Oppositifoliæ. Essential character: calyx common subimbricate, with linear scales; corolla radiate; germs compressed, vertical; down obscurely toothed, two-horned; receptacle honey-combed. There are two species, *viz.* B. asteroides, starwort-flowered boltonia; and B. glastifolia, glaucous-leaved boltonia. Both these are natives of America, and flower late in the autumn.

BOMB, in artillery, a shell or hollow ball of cast iron, having a large vent, by which it is filled with gunpowder, and which is fitted with a fuze or hollow plug, to give fire by when thrown out of a mortar, &c.: about the time when the shell arrives at the intended place, the composition in the pipe of the fuze sets fire to the powder in the shell, which blows it all in pieces, to the great annoyance of the enemy, by killing the people or firing the houses, &c. They are now commonly called shells simply in the English artillery.

These shells or bombs are of various sizes, from that of 17 or 18 inches diameter downwards. The very large ones are not used by the English, that of 13 inches diameter being the highest size now employed by them: the weight, dimensions, and other circumstances of them, and the others downwards, are as in the following table.

Diameter of the shell.	Weight of the shell.	Powder to fill them.		Powder to burst them in most pieces.	
	lbs.	lb.	oz.	lb.	oz.
13 inch	195	9	4½	7	8
10	89	4	14½	3	4
8	46	2	3½	2	0
5⅘ Royal	14½	1	1½	0	14
4⅖ Cohorn	7½	0	8	0	7

Mr. Muller gives the following proportion for all shells. Dividing the diameter of the mortar into 30 equal parts, then the other dimensions in 30ths of that diameter will be thus:

Diameter of the bore or mortar	30
Diameter of the shell	29½
Diameter of the hollow sphere	21
Thickness of metal at the fuze hole	3½
Thickness at the opposite part	5
Diameter of the fuze hole	4
Weight of shell empty	$\frac{10}{177}d$
Weight of powder to fill it . .	$\frac{2}{473}d$

Where *d* denotes the cube of the diameter of the bore in inches. But shells have also lately been made with the metal all of the same thickness quite around.

In general, the windage or difference between the diameter of the shell and mortar is one-sixtieth of the latter; also the diameter of the hollow part of the shell is seven-tenths of the same.

Bombs are thrown out of mortars or howitzers; but they may also be thrown out of cannon; and a very small sort are thrown by the hand, which are called granadoes.

Bomb *chest*, a kind of chest filled usually with bombs, sometimes only with gunpowder, placed under ground, to tear and blow it up into the air with those who stand upon it. It was formerly set on fire by means of a saucisse fastened at one end, but is now much disused.

Bomb *ketch*, a small vessel, built and strengthened with large beams for the use of mortars at sea.

BOMBARD, a piece of ordnance anciently in use, excceedingly short and thick, and with a very large mouth. There have been bombards which have thrown a ball of 300 pound weight. They made use of cranes to load them.

BOMBARDIER, a person employed about a mortar. His business is to drive the fuse, fix the shell, load and fire the mortar, and to work with the fire-workers on all sorts of fire-works, whether for war or recreation.

BOMBARDMENT, is the act of assaulting a city or fortress by throwing shells into it, in order to set it on fire, or otherwise demolish it. As one of the effects of the shell results from its weight, it is never discharged as a ball from a cannon, that is, by pointing it at a certain object: the mortars in England are fixed at an elevation of 45°.

BOMBARDO, a musical instrument of

the wind kind, much the same as the bassoon, and used as a base to the hautboy.

BOMBASINE, a name given to two sorts of stuffs, the one of silk, and the other, crossed, of cotton.

BOMBAX, in botany, English *silk cotton*, a genus of the Monadelphia Polyandria. Natural order of Columniferæ; Malvaceæ, Jussieu. Essential character: calyx five-cleft; stamina five or more; capsule woody, five-celled, five-valved; seeds woolly; receptacle five-cornered. There are four species, of which we shall notice the B. ceiba as being the most interesting: it grows to a great size in both Indies; it is one of the tallest trees in those countries; the wood is very light, and not much valued, except for canoes: their trunks are so large, as, when hollowed, to make very large ones. In Columbus's first voyage it was related, that a canoe was seen at the island of Cuba, made of one of these trees, which was ninety-five palms long, of a proportional width, and capable of containing one hundred and fifty men. The canoes now made in the West Indies from this tree frequently carry from fifteen to twenty hogsheads of sugar, from six to twelve hundred weight each, the average about twenty-five tons burthen. When sawn into boards, and then well saturated with lime-water, the wood bears exposure to the weather many years; it is also formed into laths for roofs, curing pots, and hogshead heading. When the tree decays, it becomes a nest for the macaca beetle, the caterpillar of which, gutted and fried, is esteemed by many persons one of the greatest delicacies.

BOMBIC *acid*, in chemistry. The silk worm forms an acid liquor, which was supposed to be an acid of a peculiar nature, and accordingly received, in the new nomenclature, the name of bombic acid; but Mr Murray thinks that this and some other acids formed by insects, as that by the ant, which is named formic acid, are acetic acid slightly disguised.

BOMBYLIUS, in natural history, a genus of insects of the order Diptera: the generic character is, mouth furnished with a very long porrected, setaceous, bivalve trunk, composed of horizontal valves, including setaceous piercers. The insects of this genus have somewhat the appearance of the smaller kinds of humble bees; thickly covered with erect downy hair: they fly with much rapidity, and may sometimes be observed to hang, as if suspended, over a flower, in the manner of some of the spinges, rapidly vibrating their wings, and darting off on the least disturbance to a considerable distance. There are forty-eight species according to Gmelin. The Æqualis, in the spring and early summer, is often seen in gardens and fields: and is easily distinguished by its downy bee-like body, and its straight sharp-pointed proboscis. Its body is covered with cinereous hair, and the wings are blackish along the whole length of the outer margin. The Pygmæus has the wings half black, and the other half dotted with black: thorax brown, with a white base and tip: the abdomen hairy, ferruginous: legs ferruginous: B. aureus is hairy; thorax brown; abdomen golden, from which it derives its name. It is found in Barbary. The head is covered with golden coloured hairs; the sides of the thorax are lined with golden-coloured hairs; abdomen with tufts of hairs; wings brownish at the base, the tip whitish, with six black dots; legs testaceous.

This genus is separated into three divisions, *viz.* A. distinguished by two hairy feelers: antennæ united at the base: B. sucker with three incumbent bristles; no feelers: antennæ approximate: C. antennæ distant, the last joint subulate, and two feelers.

BOMBYX. See Phalæna.

BONA *fides*, or Bona *fide*, among lawyers, is as much as to say, such a thing was done really, without either fraud or deceit.

A man is said to possess any thing *bona fide*, who is ignorant of that thing's being the property of another: on the contrary, he is said to possess a thing *mala fide*, who is concious of its being the property of another.

Bona *notabilia*, are such goods as a person dying has in another diocese besides that wherein he dies, amounting to the value of 5*l.* at least; in which case the will of the deceased must be proved, or administration granted in the court of the archbishop of the province, unless by composition or custom, any dioceses are authorised to do it, when rated at a greater sum.

Bona *patria*, an assise of countrymen, or good neighbours, where twelve or more are chosen out of the country to pass upon an assise, being sworn judicially in the presence of the party.

BOND, an obligatory instrument, or deed, in writing, whereby one binds himself to another to pay a certain sum of money or perform some certain acts; as that the obligor shall make a release, execute a sufficient conveyance of his estate, save the obligee harmless, perform the covenants of a deed, &c.

A bond contains an obligation with a penalty, and a condition generally written under it, which expressly mentions the sum that is to be paid, or other thing to be performed, and to whom, with the limited time thereof, for which the obligation is peremptorily binding.

The condition of a bond must be to do something lawful; for if it be to perform an act *malum in se*, as to kill a person, &c. it is void; likewise bonds not to use trades, &c. are unlawful and void: so also are bonds made by compulsion, by infants, and *feme coverts*, &c. but if a drunken man voluntarily gives his bond, it shall bind him; and a bond, though it be without any consideration, is binding. Where a bond has no date, or a false one is inserted therein, if it be sealed and delivered, it is a good bond: and a person shall not be charged by any bond, though signed and sealed, without delivery or words, or other thing, amounting to it. Notwithstanding a bond be made to pay money on the 30th of February, and there be no such day, the bond is good, and the money shall be paid presently. It is the same if no time is limited; in that case it must be immediately paid, or in convenient time.

If a bond be of twenty years standing, and no demand is proved to be made thereon, or good cause shewn for so long forbearance, upon pleading the payment at the day, it shall be intended paid.

Bond, *post obit*, is one that becomes payable after the death of some person, whose name is specified in it. The life of a person being uncertain, the risk attached to such bonds frees them from the shackles of the common law of usury.

Bond, in carpentry, a term among workmen; as, to make good bond, means that they should fasten the two or more pieces together, either by tenanting, mortising, or dovetailing, &c.

BONE. By bones are meant those hard, solid, well-known substances, to which the firmness, shape, and strength of animal bodies are owing; which in the larger animals, form as it were, the groundwork upon which all the rest is built. In man, in quadrupeds, and many other animals, the bones are situated below the other parts, and scarcely any of them are exposed to view; but shell-fish and snails have a hard covering on the outside of their bodies, evidently intended for defence.

The bones are the most solid part of animals. Their texture is sometimes dense, at other times cellular and porous, according to the situation of the bone. They are white, of a lamellar structure, and not flexible nor softened by heat. Their specific gravity differs in different parts. That of adult's teeth is 2.27: the specific gravity of children's teeth is 2.08. It must have been always known that bones are combustible, and that, when sufficiently burnt, they leave behind them a white porous substance, which is tasteless, absorbs water, and has the form of the original bone. The nature of this substance embarrassed the earlier chemists. But in 1771, Scheele mentioned, in his dissertation on fluor spar, that the earthy part of bones is phosphate of lime. This discovery was the first and the great step towards a chemical knowledge of the composition of bones. The component parts of bones are chiefly four; namely, the earthy salts, fat, gelatine, and cartilage. The earthy salts may be obtained, either by calcining the bone to whiteness, or by steeping it for a sufficient length of time in acids. In the first case, the salts remain in the state of a brittle white substance; in the second, they are dissolved, and may be thrown down by the proper precipitants. These earthy salts are four in number: 1. Phosphate of lime, which constitutes by far the greatest part of the whole. 2. Carbonate of lime. 3. Phosphate of magnesia, lately discovered by Fourcroy and Vauquelin. It occurs in the bones of all the inferior animals examined by these indefatigable chemists, but could not be detected in human bones. 4. Sulphate of lime, detected by Mr. Hatchett in a very minute proportion. The proportion of fat contained in bones is various. By breaking bones in small pieces, and boiling them for some time in water, Mr. Proust obtained their fat swimming on the surface of the liquid. It weighed, he says, one-fourth of the weight of the bones employed. This proportion appears excessive, and can scarcely be accounted for, without supposing that the fat still retained water. The gelatine is separated by the same means as the fat, by breaking the bones in pieces, and boiling them long enough in water. The water dissolves the gelatine, and gelatinizes when sufficiently concentrated. Hence the importance of bones in making portable soups, the basis of which is concrete gelatine, and likewise in making glue. When bones are deprived of their gelatine by boiling them in water, and of their earthy salts by steeping them in diluted acids, there remains a soft white elastic substance, possessing the figure of the bones, and known by the name of cartilage. From the experiments of Hatchett, it appears that this substance has the properties of coagulated albumen. This cartilaginous substance is the portion of the bone first formed. Hence the softness of these parts at first. The phosphate of lime is afterwards gradually deposited, and gives the bone the requisite firmness. The gelatine and fat, especially the first, give the bone the requisite degree of toughness and strength; for when they are removed, the bone becomes brittle. The relative proportion of phosphate of lime and cartilage differ exceedingly in different bones and in different animals. Ox bones, according to the analysis of Fourcroy and Vauquelin, are composed of

Solid gelatine	51
Phosphate of lime . . .	37.7
Carbonate of lime . . .	10
Phosphate of magnesia .	1.3
	100.0

See ANATOMY.

BONIS *non amovendis*, in law, is a writ directed to the sheriffs of London, &c. charging them, that a person, against whom judgment is obtained, and prosecuting a writ of error, be not suffered to remove his goods until the error is determined.

BONNET, in fortification, a small work, consisting of two faces, having only a parapet with two rows of palisadoes, of about ten or twelve feet distance: it is generally raised before the saliant angle of the counterscarp, and has a communication with the covered way, by a trench cut through the glacis and palisadoes on each side.

BONNET, in the sea-language, denotes an addition to a sail: thus they say, lace on the bonnet, or shake off the bonnet.

BONNETIA, in botany, so called in honour of M. Charles Bonnet, a genus of the Polyandria Monogynia class and order. Essential character: calyx five parted, two-parts larger; corol five-petalled, three smaller upright, two longer declinate; capsules oblong, three-celled, three-valved, many seeded. There is only one species, *viz.* B. mahuria, grows in marshy places in Cayenne and Guiana, a tree about fifteen feet high, branching chiefly towards the top. The flowers are borne on terminal spikes, and are of a purple colour.

BONTIA, in botany, so called from Jacobus Bontius, a genus of the Didynamia Angiospermia class and order. Natural order of Personatæ. Essential character: calyx five-parted; corol two-lipped; lower lip three-parted, revolute; drupe ovate, one-seeded, with the end oblique. There is but one species, *viz.* B. daphnoides, the leaves of which are thick and rather stiff, very smooth and green on both sides; corolla yellowish, with a line of dusky purple along the middle of the lower lip; birds grow fat upon the fruits, but unless the entrails are taken out as soon as the bird is killed, it becomes too bitter to be eaten.

BOOK, *liber*, the composition of a man of wit and learning, designed to communicate somewhat he has invented, experienced, or collected, to the public, and thence to posterity; being withal of a competent length to make a volume.

In this sense, a book is distinguished from a pamphlet, by its greater length: and from a tome or volume, by its containing the whole writing. According to the ancients, a book differed from an epistle, not only in bulk, but in that the latter was folded, and the former rolled up; not but that there are divers ancient books now extant, under the names of epistles.

By 8 Anne, c. 19, the author of any book, and his assigns, shall have the sole liberty of printing and reprinting the same for fourteen years, to commence from the day of the first publication thereof, and no longer; except that, if the author be living at the expiration of the said term, the sole copyright shall return to him for other fourteen years: and if any other person shall print, or import, or shall sell or expose it to sale, he shall forfeit the same, and also one penny for every sheet thereof found in his possession. But this shall not expose any person to the said forfeitures, unless the title thereof shall be entered in the register book of the Company of Stationers.

By statute, eleven copies of each book, on the best paper, shall, before publication, be delivered to the warehouse-keeper of the Company of Stationers, for the use of the Royal Library, the libraries of the two universities in England, the four universities in Scotland, the library of Sion College, the library belonging to the College of Advocates in Edinburgh, the library of Trinity College, Dublin, and the King's Inn, Dublin, on pain of forfeiting the value thereof, and also five pounds.

By Stat. 34 Geo. III. c. 20, and 41 Geo. III. c. 107, persons importing, for sale, books first printed within the united kingdom, and reprinted in any other, such books shall be seized and forfeited; and every person so exposing such books to sale, for every such offence, shall forfeit the sum of ten pounds. The penalties not to extend to books not having been printed for twenty years.

By the act of union, 40 Geo. III. c. 67, all prohibitions and bounties on the export of articles (the produce and manufacture of either country) to the other shall cease; and a countervailing duty of two-pence for every pound weight avoirdupois of books, bound or unbound, and of maps or prints, imported into Great Britain directly from Ireland, or which shall be imported into Ireland from Great Britain, is substituted.

Books, *materials of.* Several sorts of materials were used formerly in making books: plates of lead and copper, the bark of trees, bricks, stone, and wood, were the first materials employed to engrave such things upon, as men were willing to have transmitted to posterity. Josephus speaks of two columns, the one of stone, the other of brick, on which the children of Seth wrote their inventions and astronomical discoveries: Porphyry makes mention of some pillars, preserved in Crete, on which the ceremonies practised by the Corybantes in their sacrifices were recorded: Hesiod's works were originally written upon tables of lead, and deposited in the temple of the Muses, in Bœotia: the ten commandments, delivered to Moses, were written upon stone; and Solon's laws upon wooden planks. Tables of wood, box, and ivory, were common among the ancients: when of wood, they were frequently covered with wax, that people might write on them with more ease, or blot out what they had written. The leaves of the palm-tree were afterwards used instead of wooden planks, and the finest and thinnest part of the bark of such trees, as the lime, the ash, the maple, and the elm; from hence comes the word *liber*, which signifies the inner bark of the trees; and as these barks were rolled up, in order to be removed with greater ease, these rolls were called *volumen*, a volume; a name afterwards given to the like rolls of paper or parchment.

Thus we find books were first written on stones, witness the decalogue given to Moses: then on the parts of plants, as leaves, chiefly of the palm-tree; the rind and bark, especially of the tilia, or philyrea, and the Egyptian papyrus. By degrees, wax, then leather, were introduced, especially the skins of goats and sheep, of which, at length, parchment was prepared: then lead came into use; also linen, silk, horn, and lastly, paper itself.

Books, *form of.* The first books were in the form of blocks and tables: but as flexible matter came to be wrote on, they found it more convenient to make their books in the form of rolls: these were composed of several sheets fastened to each other, and rolled upon a stick, or umbilicus; the whole making a kind of column, or cylinder, which was to be managed by the umbilicus as a handle, it being reputed a crime to take hold of the roll itself: the outside of the volume was called *frons*; the ends of the umbilicus, *cornua*, horns, which were usually carved, and adorned with silver, ivory, or even gold and precious stones; the title συλλαϐος, was struck on the outside; the whole volume, when extended, might make a yard and a half wide, and fifty long. The form which obtains among us is the square, composed of separate leaves; which was also known, though little used, by the ancients.

Books, in a mercantile sense, or **Book-***keeping*, the several registers wherein merchants and other dealers keep their accounts.

A merchant's books should exhibit the true state of his affairs. They should shew the particular success of each transaction, as well as the general result of the whole; and should be so arranged, as to afford correct and ready information upon every subject for which they may be consulted.

Merchant's books are kept either by single, or according to the method of double entry. They who keep them in the former method have occasion for few books, as a journal, or day-book; and a ledger, or post-book: the former, to write all the articles following each other as they occur in the course of their business; and the other to draw out the accounts of all the debtors and creditors on the journal. This method is only proper for retail dealers, or at least for traders who have but very little business: but as for wholesale dealers, and great merchants, who keep their books according to the double entry, or Italian method, as is now most commonly done, their business requires several other books, the usefulness of which will be seen from what follows.

The most considerable books, according to the method of double entry, are, the waste-book, the journal, and the ledger; but besides these three, which are absolutely necessary, there are several others, to the number of thirteen, or even more, called subservient, or auxiliary books, which are used in proportion to the business a man has, or to the nature of the business a man carries on. These books are, the cash-book, the debt-book, the book of numeros, the book of invoices, the book of accounts current, the book of commissions, orders, or advices, &c.

The waste-book may be defined a register, containing an inventory of a merchant's effects and debts, with a distinct record of all his transactions and dealings, in a way of trade, related in a plain simple style, and in order of time as they succeed one another.

The waste-book opens with the inventory, which consists of two parts; first, the effects, that is, the money a merchant has by him, the goods he has in hand, his part of ships, houses, farms, &c. with the debts due to him; the second part of the inventory is the debts due by him to others: the difference between which and the effects is what the merchants call neat stock. When a man begins the world, and first sets up to trade, the inventory is to be gathered from a survey of the particulars that make up his real estate; but ever after is to be collected from the balance of his old books, and carried to the new.

After the inventory is fairly related in the waste-book, the transactions of trade come next to be entered down; which is a daily task, to be performed as they occur. The narrative ought to exhibit transactions, with all the circumstances necessary to be known, and no more. It should contain the names of persons with whom the merchant deals upon trust, the conditions of bargains, the terms of payment, the quantity, quality, and prices of goods, with every thing that serves to make the record distinct, and nothing else. The waste-book, if no subsidiary books are kept, should contain a record of all the merchant's transactions and dealings in the way of trade; and that not only of such as are properly and purely mercantile, but of every occurrence that affects his stock, so as to impair or increase it, such as private expences, servants fees, house-rents, money gained, &c.

The journal, or *day-book*, is the book wherein the transactions recorded in the waste-book are prepared to be carried to the ledger, by having their proper debtors and creditors ascertained and pointed out: whence it may be observed, that the great design of the journal is to prevent errors in the ledger: again, after the ledger is filled up, the journal facilitates the work required in revising and correcting it; for first the waste-book and journal are compared, and then the journal and ledger; whereas, to revise the ledger immediately from the waste-book would be a matter of no less difficulty, than to form it without the help of a journal: lastly, the journal is designed as a fair record of a merchant's business; for neither of the two other books can serve this purpose; not the ledger, by reason of the order that obtains in it, and also on account of its brevity, being little more than a large index: nor can the waste-book answer this design, as it can neither be fair nor uniform, nor very accurate, being commonly written by different hands, and in time of business. Hence it is, that in case of differences between a merchant and his dealers, the journal is the book commonly called for, and inspected by a civil judge.

In the journal, persons and things are charged debtors to other persons and things as creditors; and in this it agrees with the ledger, where the same style is used, but differs from it as to forms and order; so that it agrees with the waste-book in those very things where it differs from the ledger; and on the other hand, it agrees with the latter in the very point wherein it differs from the former.

It may be observed, that every case or example of the waste-book, when entered into the journal, is called a journal post, or entrance; thus the examples above make three direct posts.

Accounts in the ledger consist of two parts, which in their own nature are directly opposed to, and the reverse of one another, and are therefore set fronting one another, and on opposite sides of the same folio. Thus all the articles of the money received go to the left side of the cash account; and all the articles or sums laid out are carried to the right. In like manner the purchase of goods is posted to the left side of the accounts of the said goods, and the sale or disposal of them to the right.

Transactions of trade, or cases of the waste-book, are also made up of two parts, which belong to different accounts, and to opposite sides of the ledger, *e. g.* If goods are bought for ready money, the two parts are, the goods received, and the money delivered; the former of which goes to the left side of the account of the said goods, and the latter to the right side of the cash account.

The two parts in any case in the waste-book, when posted to the journal, are denominated the one the debtor, the other the creditor, of that post; and when carried from thence to the ledger, the debtor, or debtor part, is entered upon the left side (hence called the debtor side) of its own account, where it is charged debtor to the creditor part: again, the creditor, or creditor part, is posted to the right side, or creditor side of its account, and made creditor by the debtor part. Hence Italian book-keeping is said to be a method of keeping accounts by double entry, because every single case of the waste-book requires at least two entrances in the ledger, *viz.* one for the debtor, and another for the creditor.

From what has been said, it is evident that the terms debtor and creditor are nothing more than marks or characteristics stamped upon the different parts of transactions in the journal, expressing the relation of these parts to one another, and shewing to which side of their respective accounts in the ledger they are to be carried.

Having thus far explained the meaning of the terms debtor and creditor, we shall now proceed to the ledger, or principal book of accounts.

Of the ledger. The ledger is the principal book, wherein all the several articles of each particular account, that lie scattered in other books, according to their dates, are collected and placed together in spaces allotted for them, in such a manner, that the opposite parts of every account are directly set fronting one another, on opposite sides of the same folio.

The ledger's folios are divided into spaces for containing the accounts, on the head of which are written the titles of the accounts, marked Dr. on the left hand page, and Cr. on the right: below which stand the articles, with the word *To* prefixed on the Dr. side, and the word *By* on the Cr. side; and upon the margin are recorded the dates of the articles, in two small columns allotted for that purpose. The money columns are the same as in other books; before them stand the folio column, which contains figures, directing to the folio where the corresponding ledger-entrance of each article is made; for every thing is twice entered in the ledger, *viz.* on the Dr. side of one account, and again on the Cr. side of some other account; so that the figures mutually refer from the one to the other, and are of use in examining the ledger. Besides these columns, there must be kept in all accounts, where number, measure, weight, or distinction of coins, is considered, inner columns, to insert the quantity; and for the ready finding any account in the ledger, it has an alphabet, or index, wherein are written the titles of all accounts, with the number of the folio where they stand.

How the ledger is filled up from the journal. 1. Turn to the index, and see whether the Dr. of the journal-post to be transported be written there; if not, insert it under its proper letter, with the number of the folio to which it is to be carried. 2. Having distinguished the Dr. and the Cr. sides, as already directed, recording the dates, complete the entry in one line, by giving a short hint of the nature and terms of the transaction, carrying the sum to the money columns, and inserting the quantity, if it be an account of goods, &c. in the inner columns, and the referring figure in the folio column. 3. Turn next to the Cr. of the journal-post, and proceed in the same manner with it, both in the index and ledger; with this difference only, that the entry is to be made on the Cr. side, and the word *By* prefixed to it. 4. The post being thus entered in the ledger, return to the journal, and on the margin mark the folios of the accounts, with the folio of the Dr. above, and the folio of the Cr. below, and a small line between them thus $\frac{2}{4}$. These marginal numbers of the journal are a kind of index to the ledger, and are of use in examining the books, and on other occasions. 5. In opening the accounts in the ledger, follow the order of the journal; that is, beginning with the first journal-post, allow the first space in the ledger for the Dr. of it, the next for the Cr. the third for the Dr. of the following post, if it be not the same with some of those already opened, and so on till the whole journal be transported; and supposing that, through inadvertency, some former space has been allowed too large, you are not to go back to subdivide it, in order to erect another account in it.

Though these rules are formed for simple posts, where there is but one Dr. and one Cr. yet they may be easily applied to complex ones.

Cash book. This is the most important of the auxiliary books. It is so called, because it contains, in debtor and creditor, all the cash that comes in and goes out of a merchant's stock. The receipts on the debtor's side; the persons of whom it was received, on what, and on whose account, and in what specie; and the payments on the creditor's side; mentioning also the specie, the reasons of the payments, to whom, and for what account they are made.

Books of debts, or payments, is a book in which is written down the day on which all sums become due, either to be received or paid, by bills of exchange, notes of hand, merchandises bought or sold, or otherwise. By comparing receipts and payments, one may, in time, provide the necessary funds for payments, by getting the bills, notes, &c. due to be paid, or by taking other precautions.

Book of numeros, or wares. This book is kept, in order to know easily all the merchandises that are lodged in the warehouse, those that are taken out of it, and those that remain therein.

Book of invoices. This book is kept, to preserve the journal from erasures, which are unavoidable in drawing up the accounts of invoices of the several merchandises received, sent out, or sold; wherein one is obliged to enter very minute particulars. It is also designed to render those invoices easier to find than they can be in the waste-book, or journal.

Book of accounts current. This book serves to draw up the accounts which are to be sent to correspondents, in order to settle them in concert, before they are balanced in the ledger; it is properly a duplicate of the accounts current, which is kept to have recourse to occasionally.

The other mercantile books, as the book of commissions, orders, or advices; the book of acceptances of bills of exchange; the book of remittances; the book of expenses; the copy-book of letters; the book of postage; the ship-books; and the book of work-men; require no description. To these may be added others, which depend on the greater or lesser accuracy of the merchants and bankers, and on the several kinds of trade carried on by particular dealers.

Book-*binding*, the art of gathering and sewing together the sheets of a book, and covering it with a back, &c. It is performed thus: the leaves are first folded with a folding-stick, and laid over each other in the order of the signatures; then beaten on a stone with a hammer, to make them smooth, and open well, and afterwards pressed. While in the press they are sewed upon bands, which are pieces of cord or pack thread; six bands to a folio book; five to a quarto, octavo, &c. which is done by drawing a thread through the middle of each sheet, and giving it a turn round each band, beginning with the first, and proceeding to the last. After this the books are glued, and the bands opened and scraped, for the better fixing the paste-boards; the back is turned with a hammer, and the book fixed in a press between two boards, in order to make a groove for fixing the pasteboards: these being applied, holes are made for fixing them to the book, which is pressed a third time. Then the book is at last put to the cutting-press, betwixt two boards, the one lying even with the press for the knife to run upon; the other above it, for the knife to run against: after which the paste-boards are squared.

The next operation is the sprinkling the leaves of the book, which is done by dipping a brush into vermilion and sap-green, holding the brush in one hand, and spreading the hair with the other: by which motion the edges of the leaves are sprinkled in a regular manner, without any spots being bigger than the others.

Then remains the covers, which are either of calf-skin, or of sheep-skin; these being moistened in water, are cut out to the size of the book, then smeared over with paste made of wheat flour, and afterwards stretched over the pasteboard, on the outside, and doubled over the edges withinside; after having first taken off the four angles, and indented and platted the cover at the head-band: which done, the book is covered, and bound firmly between two bands, and then set to dry. Afterwards it is washed over with a little paste and water, and then sprinkled fine with a brush, unless it should be marbled, when the spots are to be made larger, by mixing the ink with vitriol. After this the book is glazed twice, with the white of an egg beaten, and at last polished with a polishing-iron passed hot over the glazed cover.

BOOKSELLER, one who trades in books, whether he prints them himself, or gives them to be printed by others.

Booksellers are in many places ranked among the members of universities, and entitled to the privilege of students, as at Tubingen, Saltsburg, and Paris, where they have always been distinguished from the vulgar and mechanical traders, and exempted from divers taxes and impositions laid upon other companies.

The traffic of books was anciently very inconsiderable, in so much, that the book-merchants, both of England, France, and

Spain, and other countries, were distinguished by the appellation of stationers, as having no shops, but only stalls and stands in the streets. During this state, the civil magistrates took little notice of the booksellers, leaving the government of them to the universities, to whom they were supposed more immediate retainers; who accordingly gave them laws and regulations, fixed prices on their books, examined their correctness, and punished them at discretion.

But when, by the invention of printing, books and booksellers began to multiply, it became a matter of more consequence, and the sovereigns took the direction of them into their own hands; giving them new statutes, appointing officers to fix prices, and grant licences, privileges, &c. Authors frequently complain of the arts of booksellers. Lord Shaftsbury gives us the process of a literary controversy blown up by the booksellers. The publication of books depends much on the taste and disposition of booksellers. Among the German writers, we find perpetual complaints of the difficulty of procuring booksellers: many are forced to travel to the book fairs at Frankfort or Leipsic, to find booksellers to undertake the impression of their works.

BOOM, in the sea language, a long piece of timber, with which the clue of the studding-sail is spread out: and sometimes the boom is used to spread or boom out the clue of the mainsail.

Boom denotes also a cable stretched athwart the mouth of a river or harbour, with yards, topmasts, battling or spars of wood lashed to it, to prevent an enemy's coming in.

BOOPIS, in botany, *bull's eye*, a genus of the Syngenesia Segregata class and order. Calyx one-leaved, many parted, many-flowered; florets tubular; receptacle chaffy; seeds each involved in its proper calycle, and crowned with its permanent teeth. Two species.

BOOT *topping*, in naval affairs, signifies the operation of scraping off the grass, slime, shells, &c. which adhere to the bottom of the ship, near the surface of the water, and daubing it over with a mixture of tallow, sulphur, and resin; it is chiefly performed where there is no dock or other commodious situation for careening, or when the hurry of a voyage renders it inconvenient to have the whole bottom cleansed.

Boot *tree*, or **Boot** *last*, an instrument used by shoemakers to widen the leg of a boot. It is a wooden cylinder slit into two parts, between which, when it is put into the boot, they drive by main force a wedge or quoin.

BOOTES, a constellation of the northern hemisphere, consisting of 23 stars, according to Ptolemy's catalogue; and of 45, in Mr. Flamstead's catalogue.

BORACIC *acid*. See Borax.

BORAGO, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aspenefoliæ. Essential character: corolla rotated; throat closed with rays. There are five species. B. officinalis, common borage, is rough, with white stiff prickly hairs; calyx divided to the very base, as is also the corolla, but it falls off in one piece; tube very short and white; segments acute. The common colour of the corolla is blue; but it varies to flesh-coloured and white. It is a biennial plant, flowering from May to August. Borage was formerly in great request, being reckoned one of the four cordial flowers. The whole herb is succulent and mucilaginous, having a faint smell when bruised. The juice affords a true nitre. This plant came originally from Aleppo.

BORASSUS, in botany, a genus of plants, the characters of which are not well ascertained. Class Appendix Palmæ, Linnæus. Essential character: corolla three-parted; male stamina six; female styles three; drupe three-seeded. There is but one species, with its varieties, viz. B. flabelliformis, has a dark-coloured bark; the wood is a dark-brownish red, and has a soft pith in the middle; fronds decussate on the top of the trunk; stipe near six feet in length, flat, and a little hollow, with rough spines along the edges; below, near a span in breadth; above, not more than a palm; the leaf part is large, and folded like a fan or umbrella, for which purpose it is used. The male and female flowers are on different trees, which have been considered as distinct species. This tree is from twenty-five to thirty feet in height, two feet thick at bottom and one at top. The fruit is as large as a child's head. Wine and sugar are made from the sap of this palm. It is a native of Ceylon, the coast of Coromandel, Java, &c.

BORATES, salts formed with the boracic acid. See the next article.

BORAX, in chemistry, is a name given to a species of white salt much used by various artists. Its use in soldering metals appears to have been known to Agricola. Borax is found mixed with other substances in Thibet. It seems to exist in some lands adjacent to lakes, from which it is extracted by water, and deposited in those lakes; whence, in summer, when the water is shallow, it is extracted and carried off in large lumps. Sometimes the water in these lakes is admitted into reservoirs, at the bottom of which, when the water is exhaled by the summer's heat, this salt is found. Hence it is carried to the East Indies, where it is in some measure purified and crystallized; in this state it comes to Europe, and is called tineal. In other parts of Thibet, it seems, by accounts received from China, they dig it out of the ground at the depth of about two yards, where they find it in smaller crystalline masses.

Borax, or sub-borate of soda. This salt, the only one of the borates which has been accurately examined, is supposed to have been known to the ancients, and to be the substance denominated chrysocolla by Pliny. At any rate, it is mentioned by Geber as early as the ninth century, under the name of borax. Its composition was first pointed out by Geoffroy, in 1732, and Baron, in 1748. Bergman demonstrated that it has an excess of base, and is therefore in the state of a sub-borate.

Borax, purified, may be obtained crystallized in hexangular prisms, of which two sides are much broader than the remainder, and terminated by triangular pyramids; it is of a white colour: its specific gravity is 1.740: it converts vegetable blues to green: its taste is styptic and alkaline; it is soluble in twenty times its weight of water, of the temperature of 60°, and six times its weight of boiling water: when exposed to the air it effloresces slowly and slightly: when heated, it swells, loses about four-tenths of its weight, becomes ropy, and then assumes the form of a light, porous, and very friable mass, known by the name of calcined borax; in a strong heat it melts into a transparent glass still soluble in water. When two pieces of borax are struck together in the dark, a flash of light is emitted. This salt, according to Bergman, is composed of

Acid . . .	39
Soda . . .	17
Water . .	44
	100

Though borax has been in common use for nearly three centuries, it was only in 1702 that Homberg, by distilling a mixture of borax and green vitriol, discovered the boracic acid. He called it narcotic or sedative salt, from a notion of his that it possessed the properties indicated by these names. Geoffroy afterwards discovered, that borax contained soda; and, at last, Baron proved, by a number of experiments, that borax is composed of boracic acid and soda; that it may be reproduced by combining these two substances; and that therefore the boracic acid is not formed during the decomposition of borax, as former chemists had imagined, but is a peculiar substance, which pre-existed in that salt. This acid, for purposes of experiment, is obtained from the purified borax of commerce, by one of the following processes: 1. To a solution of borax in boiling water, add half its weight of sulphuric acid, previously diluted with an equal quantity of water. Evaporate the solution a little; and on cooling, shining, scaly crystals will appear, which consist of boracic acid. Let them be well washed with distilled water, and dried on filtering paper. 2. Let any quantity of borax be put into a retort, with half its weight of sulphuric acid, and half its weight of water. Boracic acid may be obtained by distillation, and may be purified by washing in water, &c. as before. Boracic acid has the following qualities: 1. It has a solid form, is destitute of smell, and nearly so of taste: 2. It fuses, when heated, and loses its water of crystallization. If the heat be increased suddenly, before it has lost its water of crystallization, it sublimes; but, otherwise, it melts into a glass, which is permanent in the strongest fire: 3. It is soluble in twelve parts of cold water, and in three or four of boiling water: 4. This solution reddens vegetable blue colours, and effervesces with alkaline carbonates: 5. It is soluble in alcohol, and the solution burns with a beautiful green flame: 6. It combines with alkalies and earths; but the only important combination which it forms is with soda.

BORBONIA, in botany, so called from Gaston Bourbon; a genus of the Diadelphia Decandria class and order. Natural order of Papilionaceæ or Leguminosæ. Essential character: calyx acuminate, spiny; stigma emarginate; legume mecronate. There are six species. B. ericifolia, is a small subvillose shrub, with small ovate linear leaves, nerveless, smooth above, villose beneath, revolute; heads sessile with small flowers. These plants grow naturally at the Cape of Good Hope, where they rise to the height of ten or twelve feet; but they are seldom more than four or five in Europe.

BORDURE, in heraldry, a cutting off from within the escutcheon, all round it, about one-fifth of the field, serving as a difference in a coat of arms, to distinguish families of the same name, or persons bearing the same coat.

BORE, among engineers, denotes the diameter of the barrel of a gun or cannon, or rather its whole cavity.

Bore, *square*, among mechanics, a square piece of well-tempered steel, fitted into a handle, serving to widen holes, and make them perfectly round.

BOREALIS. See the article Aurora.

BORELLI, (J. Alphonso) a celebrated philosopher and mathematician, born at Naples the 28th of January, 1608. He was professor of philosophy and mathematics in some of the most celebrated universities of Italy, particularly at Florence and Pisa, where he became highly in favour with the princes of the house of Medicis. But having been concerned in the revolt of Messina, he was obliged to retire to Rome, where he spent the remainder of his life, under the protection of Christina, Queen of Sweden, who honoured him with her friendship, and, by her liberality towards him, softened the rigour of his hard fortune. He continued two years in the convent of the regular clergy of St. Pantaleon, called the "Pious Schools," where he instructed the youth in mathematical studies. And this study he prosecuted with great diligence for many years afterwards, as appears by his correspondence with several ingenious mathematicians of his time, and the frequent mention that has been made of him by others, who have endeavoured to do justice to his memory. He wrote a letter to Mr. John Collins, in which he discovers a great desire, and endeavours to promote the improvement of those sciences; he also speaks of his correspondence with, and great affection for, Mr. Henry Oldenburg, Secretary of the Royal Society; and Dr. Wallis; and of the then late learned Mr. Boyle. He died of a pleurisy, in his 72d year, December 31, 1679. His principal work was "De Motu Animalium," in two volumes, small 4to. The object of this work was to explain the functions of animal bodies, on mechanical principles. He describes the fibres of the muscles, and measures the power or force which each possesses, and the power of them collectively. He points out in what manner that power is increased or diminished, by the manner in which the fleshy fibres are joined to the tendons. He calculates the power of the heart, in propelling the blood, which he supposes equal to 180,000 pounds weight. In his calculations Borelli was found to have erred in many respects, but his principles were generally admitted.

BORER, an instrument invented for the purpose of searching or exploring the nature of soils; it consists of iron rods, about six feet long, made to screw into one another; to the lower one is fixed a steel point: with an instrument of this kind, two men will easily sound the depth of twelve feet in a quarter of an hour, if they do not meet with stones. When the rod becomes too heavy to be conveniently managed with the hand, it may be raised by a rope fastened at one end to the handle, and at the other to a roller, or kind of windlass, erected at a proper height, perpendicularly over the hole, and turned with one or two handles. The toughest iron is used for making this instrument, which should be well hammered, till its surface is quite smooth and even; for the least roughness and inequality would occasion a friction, that must greatly retard its working. For the same reason, and also to increase the force of its fall, it is necessary, that it should be perfectly straight, nor should it ever be struck with a mallet, &c. to force it down, because a blow might bend it, and it would easily break afterwards. A bit, like that of an auger, proportioned to the thickness of the rod, may at any time, when necessary, be substituted instead of the steel point, to draw up a sample of the substance from the very bottom of the sounding.

BORING, in a general sense, the art of perforating, or making a hole through any solid body.

Boring, in mineralogy, a method of piercing the earth with scooping irons, which, being drawn back at proper times, bring up with them samples of the different strata through which they have passed; by the examination of which the skilful mineralogist will be able to guess whereabouts a vein of ore may lie, or whether it will be worth while to open a mine there or no.

Boring *of water-pipes*. The method of boring alder poles for water-pipes is thus: being furnished with poles of a fit size, horses or tressels are procured of a due height, both to lay the poles, and rest the augre on in boring; they also set up a lathe, whereby to turn the lesser ends of the poles, and adapt them to the cavities of the greater ends of others, in order to make the joint shut each pair of poles together. The outer, or concave part, is called the female, and the other, or inner, the male part of the joint. In turning the male part, they make a channel, or small groove in it, at a proper distance from the end; and, in the female part, bore a small hole to fit over this channel; they then bore through their poles, sticking up great nails at each end, to guide them right; but they commonly bore a pole at both ends, so that if it be crooked one way, they can nevertheless bore it through, and not spoil it.

BORONIA, in botany, a genus of the Octandria Monogynia class and order. Calyx four-parted; petals four; antheræ pedicelled below the summits of the filaments; style, from the top of the germ, very short; stigma capitate; capsule four-united; seeds coated. There are four species, natives of New South Wales.

BOROUGH, or **Burgh**, in a general sense, signifies a town, or a corporation, which is not a city. The word, in its original signification, is by some supposed to have meant a company, consisting of ten families, which were bound together at each other's pledge. Afterwards, as Verstegan has it, borough came to signify a town, having a wall, or some kind of enclosure around it. And all places that in old times had the name of borough, it is said, were fortified, or fenced in some shape or other. Borough is a place of safety and privilege; and some are called free burghs, and the tradesmen in them free burgesses, from a freedom they had granted to them originally, to buy and sell without disturbance, and exempt them from toll.

Borough is now particularly appropriated to such towns or villages as send burgesses or representatives to parliament, whether they may be incorporated or not.

They are distinguished into those by charter or statute, and those by prescription or custom; the number in England is one hundred and forty-nine, some of which send one, but the most of them two representatives.

Boroughs, *royal*, in Scotland, are corporations made for the advantage of trade, by charters granted by several of their kings, having the privilege of sending commissioners to represent them in parliament, besides other peculiar immunities. They form a body of themselves, and send commissioners each to an annual convention at Edinburgh, to consult for the benefit of trade, and their general interest.

Borough, *English*, a customary descent of lands or tenements, in certain places, by which they descend to the youngest instead of the eldest son; or, if the owner have no issue, to the younger instead of the elder brother. The custom goes with the land, although there be a devise or feoffment at the common law to the contrary. The reason of this custom, says Littleton, is, because the youngest is presumed, in law, to be least able to provide for himself.

Borough-head, or *headborough*, called also borough-holder, or bursholder, the chief man of the *decenna*, or hundred, chosen to speak and act in behalf of the rest.

Headborough also signifies a kind of head constable, where there are several chosen as his assistants, to serve warrants, &c.

BORROWING, when money, corn, grain, gold, or other commodity, merely esteemed according to its price, is borrowed, it is repaid by returning an equal quantity of the same thing, or an equal value in money. If money is borrowed, it is always understood that interest is payable, and it is by law demandable; but when a house, or a horse, &c. is borrowed, the restoration of the identical property is always understood; or if a thing be used for any other, or more purposes, than those for which it was borrowed, or be lost, the party may have his action on the case for it.

BOS, in zoology, *the ox*, a genus of quadrupeds of the order of Pecora. The generic character is, horns concave, turned outwards, lunated, smooth; front teeth eight in the lower jaw; canine teeth none. B. taurus, the bison, from which the several races of common cattle have been gradually derived, is found wild in many parts, both of the old and the new continent; inhabiting woody regions, and arriving at a size far larger than that of the domestic or cultivated animal. In this its native state of wildness, the bison is distinguished not only by his size, but by the superior depth and shagginess of his hair, which, about the head, neck, and shoulders, is sometimes of such a length as almost to touch the ground. His horns are rather short, sharp-pointed, extremely strong, and stand distant from each other at their bases, like those of the common bull. His colour is sometimes of a dark blackish brown, and sometimes rufous brown; his eyes large and fierce; his limbs extremely strong, and his whole aspect in a degree savage and gloomy. See Plate III. Mammalia, fig. 2.

The principal European regions where this animal is at present found are, the marshy forests of Poland, the Carpathian mountains, and Lithuania. Its chief Asiatic residence is the neighbourhood of Mount Caucasus; but it is also found in other parts of the Asiatic world.

The common ox is, in reality, the bison reduced to a domestic state; in which, in different parts of the world, it runs into as many varieties as the sheep; differing widely in size, form, and colour, according to climate and other circumstances. Its importance in this its domestic state needs not be mentioned. Formerly the ox constituted the whole riches of mankind; and he is still the basis of the wealth of nations, which subsist and flourish in proportion to the cultivation of their lands and the number of their cattle.

B. Americanus.—Horns round, distant at the base, short, black, and pointing outwards; mane long, woolly; gibbosity of the back large and fleshy; neck thick; hind-parts slender; tail a foot long, tufted at the end; hair of the head and bunch long, woolly, waving, rusty brown. It grows to a vast size, and has been found to weigh sixteen hundred, and even two thousand four hundred pounds; the strongest man cannot lift one of the skins from the ground. These were the only animals which bore any affinity to the European cattle, on the first discovery of the American continent, and might have been made to answer every purpose of the European cow; but the natives being in a savage state, and living chiefly by chase, had never attempted the domestication of the animal.

The Urus, or wild bull, is a variety of the ox kind, and is chiefly to be met with in the extensive forests of Lithuania. It grows to a size almost equal to the elephant, and is quite black; the eyes are red and fiery, the horns thick and short, and the forehead covered with a quantity of curled hair; the neck is short and strong, and the skin has an odour of musk. The female, though not so big as the male, exceeds the largest of our bulls in size: nevertheless her udder is extremely small. Upon the whole, however, this animal, which greatly resembles those of the tame kind, probably owes its variety to its natural wildness, and the richness of the pastures where it is produced. Fig. 1.

The Zebu is another variety of the Bos Taurus. They are all equally docile and gentle when tamed, and are in general covered with fine glossy hair, softer and more beautiful than that of the common cow. Their humps are of different sizes, in some weighing from forty to fifty pounds, but in others less. That part is in general considered as a great delicacy, and when dressed has much the appearance and taste of udder. Fig. 3.

The Bisons of Madagascar and Malabar are of the great kind; those of Arabia Petrea, and most parts of Africa, are of the Zebu or small kind. In America, especially towards the north, the American ox is well known. They herd together in droves of from one or two hundred to eight or ten thousand, on the banks of the Mississippi and Missouri, where the inhabitants hunt them, their flesh being esteemed good eating. They all breed with the tame cow.

The oxen of India are of different sizes, and are made use of in travelling, as substitutes for horses. Their common pace is soft. Instead of a bit, a small cord is passed through the cartilage of the nostrils, which is tied to a larger cord, and serves as a bridle. They are saddled like horses; and, when pushed, move very briskly: they are likewise used in drawing chariots and carts. For the former purpose white oxen are in great esteem, and much admired. They will perform journies of sixty days, at the rate of from twelve to fifteen leagues a day, and their travelling pace is generally a trot. In Persia there are many oxen entirely white, with small blunt horns, and humps on their backs. They are very strong, and carry heavy burthens. When about to be loaded, they drop down on their knees like the camel, and rise when their burthens are properly fastened.

Bos *babylus*, or *buffalo*, ox with horns lying backwards, turning inwards, and flat on the fore part. In its general appearance, the buffalo is so nearly allied to the common ox, that, without an attentive examination, it might pass for a variety of the same animal. It differs, however, in the form of its horns, and in some particulars relative to its internal structure. The buffalo is rather superior in size to the common ox; the head larger in proportion; the forehead higher; the muzzle of a longer form, but at the same time broad and square: but it is principally the form of the horns that distinguishes the buffalo. They are large, and of a compressed or depressed form, with the exterior edge sharp. The buffalo has an appearance of great strength, and a more ferocious or malignant aspect than the bull, owing to the convexity of his forehead, the smallness of his eyes, the flatness of his muzzle, and the flatter and more inclined position of his horns.

The general or prevailing colour of the buffalo is blackish, except the hair on the top of the forehead, and that at the tip of the tail, which is of a yellowish white; the skin itself is also of a black colour; and from this general cast it is but very seldom observed to vary. As the buffalo in his domesticated state is, in general, larger and stronger than the ox, he is employed with advantage in different kinds of labour. Buffaloes are made to draw heavy loads, and are commonly directed and restrained by means of a ring passed through the nose. Two buffaloes yoked, or rather chained to a cart, are able to draw as much as four strong horses. As they carry their neck and head low, the whole weight of their body is employed in drawing; and their mass much surpasses that of a labouring horse. In its habits the buffalo is much less cleanly than the ox, delighting to wallow in the mud; and, next to the hog, may be considered as the dirtiest of domesticated quadrupeds. His voice is deeper, more uncouth, and hideous, than that of the bull. The milk of the female buffalo is said, by some authors, to be not so good as that of the cow; but it is more plentiful, and is used for the purposes of the dairy in the warmer regions.

Italy is the country where buffaloes are at present most common, in a domesticated state; being used, as in India, both for the dairy and for draught. The district of the Pontine marshes is the spot which may be considered as their principal station. In India this animal is occasionally used for the saddle, as a substitute for the horse.

The buffalo, like other animals of this genus, admits of varieties as to size and figure. Of these the most remarkable is the small naked Indian buffalo of Mr. Pennant, which is the size of a runt, with a nearly naked body, thinly beset with bristly hair; the rump and thighs quite bare: the first being marked on each side with dusky stripes pointing downwards, the last with two transverse stripes; the horns compressed sideways, taper, and sharp at the point. It is a native of India. Another variety, still smaller, is said to occur in the mountains of the Celebes, which are full of caverns. This variety is of the size of a middling sheep, and is seen in small herds, very wild, and difficult to be taken; and even in confinement are so fierce, that Mr. Pennant records an instance of fourteen stags being destroyed in the space of a single night by one of these animals, which was kept in the same paddock, Fig. 4.

Bos *moschatus*, or *musk ox*, having very long pendant hair, and horns (in the male approximated at the base) bending inwards and downwards, and outwards at the tips. It is a native of North America, where it appears to be a very local animal, being found first in the tract between Churchill river and that of the Seals, on the west side of Hudson's Bay, and is very numerous between the latitudes of 66° and 73° north, which is as far as any tribes of Indians go. This animal is but of small size, being rather lower than the deer, but larger or thicker in body. The hair in the male is of a dusky red colour, extremely fine, and so long as to trail on the ground, and renders the animal a seemingly shapeless mass, without distinction of head or tail; the legs are very short; the shoulders rise into a lump, and the tail is short, being a kind of stump of a few inches only, with very long hairs. Beneath the hair, on all parts of the animal, is a fine cinereous wool, which is said to be more beautiful than silk when manufactured into stockings and other articles. The horns are closely united at the base, bending inwards and downwards; but turning outwards towards the tips, which are very sharp; near the base the horns are two feet in girth, but are only two feet long, when measured along the curvature; the weight of a pair, separated from the head, is sometimes sixty pounds.

Bos *grunniens*, or *yak*, (having, with cylindric horns curving outwards, very long pendant hair, and extremely villose, horse-like tail,) is about the size of an English bull, which he resembles in the general figure of the body, head, and legs; it is covered all over with a thick coat of long hair; the head is rather short, crowned with two smooth round horns, which, tapering from the root upwards, terminate in sharp points; they are arched inwards, bending towards each other, but near the extremities are a little turned back.

They are a very valuable property to the tribes of itinerant Tartars, called Duckba, who live in tents, and tend them from place to place: they at the same time afford their herdsmen an easy mode of conveyance, a good covering, and wholesome subsistence. They are never employed in agriculture, but are extremely useful as beasts of burden; for they are strong, sure-footed, and carry a great weight. Tents and ropes are manufactured of their hair; and among the humbler ranks of herdsmen, caps and jackets are made of their skins. Their tails are esteemed throughout the East, as far as luxury and parade have any influence on the manners of the people. In India no man of fashion ever goes out, or sits in form at home, without two chowrabadars, or brushers attending him, each furnished with one of these tails, mounted on silver or ivory handles, to brush away the flies. The Chinese dye them of a beautiful red, and wear them as tufts to their summer bonnets. The yak is the most fearful of animals, and very swift; but when chased by men or dogs, and finding itself nearly overtaken, it will face its pursuers, and hide its hind parts in some bush, and wait for them; imagining that if it could conceal its tail, which was the object they were in search of, it would escape unhurt.

Bos *caffer*, or *Cape ox*, (having the horns very broad at the base, then spreading downwards, next upwards, and at the tips curving inwards); inhabits the interior parts of Africa, north of the Cape of Good Hope, and is greatly superior in size to the largest English ox. It is of a very strong and masculine form, with a fierce and malevolent aspect. Its colour is a deep cinereous brown; the hair on the body is rather short, but that on the head and breast very long, coarse, and black, hanging down the dew-lap, like that of a bison; from the hind part of the head to the middle of the back is also a loose black mane; the tail is nearly naked at the base; the remainder being covered with long loose hair. These animals are found in large herds, in the desert parts beyond the Cape; and, if met in the narrow parts of woods, are extremely dangerous, rushing suddenly on the traveller, goring and trampling both man and horse under foot. It is also said, that they will often strip off the skin of such animals as they have killed, by licking them with their rough tongues, as recorded by some of the ancient authors of the bison.

BOSCIA, in botany, a genus of the Tetrandria Trigynia class and order. Calyx four-toothed; corolla four-petalled; capsule four-celled. One species, found at the Cape.

BOSEA, in botany, from Bose, a senator of Leipsic, a genus of the Pentandria Digynia class and order. Essential character: calyx five-leaved; corolla none; berry one-seeded. There is but one species, *viz*. B. yervâmora, golden rod tree, is a strong woody shrub, with a stem as large as a man's leg, the branches come out very irregularly, and make considerable shoots in summer; these branches retain their leaves till spring, when they fall off, and new leaves are produced soon after. It is a native of the Canary islands, and is also found in some of the West India islands.

BOSSIÆA, in botany, a genus of the Diadelphia Decandria: calyx two-lipped, the upper lip inversely heart-shaped; banner with two glands at the base; keel of two petals: legume pedicelled, compressed, many-seeded. One species, a native of New Holland.

BOSTRICHUS, in natural history, a genus of insects of the order Coleoptera: attennæ clavate, the club solid; thorax convex, slightly margined; head inflected and hid under the thorax. There are about thirty species. They are a very fertile and voracious tribe, and destructive to woods, making those deep irregular channels, so often observable in the bark and wood of trees. They are found chiefly in Europe and America.

BOTANY, is that science which teaches a knowledge of the vegetable kingdom, as its name, derived from *βοτανη*, an herb or grass, expresses. This word may be easily traced to its primitive *βοω*, or *βοσκω*, to feed, and since plants have ever been regarded as the food of a large portion of animals, the aptness of its derivation is apparent. This study, in its most limited sense, includes the practical discrimination, methodical arrangement, and systematical nomenclature of vegetables: while, in a more enlarged view, it comprises the anatomy and functions of their several parts, together with the various qualities and uses which render them serviceable either to mankind or the brute creation. In this respect botany may be considered as a vast and almost boundless study; nor is the merely systematical department of botany or natural history in general, when cultivated on philosophical principles, inferior to any other science, in extent or utility, as an exercise for the discriminative powers of the mind. The necessity of a regular method of classification, which is calculated to arrange and dispose the whole vegetable kingdom, cannot be doubted, since the most experienced and intelligent botanists of the present day have scarcely been able to reckon, within ten thousand, how many species of plants there may be in the world.

An attention to the vegetables, on all sides spread around him, must have been one of the earliest occupations of man in a state of nature; and this attention was doubtless quickened to a further contemplation of their beauty and utility, when it was discovered, that, independently of affording gratification to the senses, some were provided as an aliment for the body, and that others contained a soothing balm for corporeal sufferings. Hence we may infer, that the study of plants has, through every age and in every clime, excited the attention of mankind; yet it is truly remarked by a late elegant writer, Dr. Pulteney, that "in the enlightened ages of Greece and Rome, and under the most flourishing state of Arabian literature, botany, as a science, had no existence. Nor was it till some time after the revival of learning, that those combinations and distinctions were effectually discovered, which in the end, by giving rise to system, have raised the study of plants to that rank it holds at present in the scale of knowledge.'

In the early history of Britain, we find that herbs were cultivated and studied with considerable assiduity by the Druids, who applied this knowledge with much effect to the purposes of superstition as well as medicine, and thus appropriated to themselves the offices both of priests and physicians. Historians inform us that the misletoe was held by our ancestors in such veneration, that it was only allowed to be cut by a priest, and with a golden knife: when thus prepared, it was dispensed as a charm to prevent sterility, and to overcome the fatal effects of poison. We learn from Pliny, that various superstitious rites with respect to many other plants were also carefully observed by the Druids. Vervain and savin were among the number; the former of these being used as a means to conciliate friendship, and the latter as an antidote to misfortunes. A small portion of the mountain-ash was believed to act as a charm against the powers of witchcraft, and this idea is still prevalent in the highlands of Scotland, where it is usual to drive cattle with a switch of this tree, in order that they may be preserved from the evils of enchantment.

The Saxons appear to have made but little proficiency in the investigation of plants, though some of the Saxon manuscript herbals shew that the study was not altogether disregarded by this people. Their chief aim was, to be acquainted with plants in a medicinal point of view. Botany indeed was involved in the utmost obscurity, being merely studied as an auxiliary to astrology, even to the middle of the 16th century; for at that period was publi hed "A Lyttel Herbal of the Properties of Herbs, newly amended and corrected, with certain additions at the end of the boke, declarying what herbs hath influence of certain starres and constellations, whereby may be chosen the best and most lucky times and days of their ministration, according to the Moon being in the signs of Heaven, the which is daily appointed in the almanack; made and gathered in the year M. D. L, xii. Feb. by Anthony Ascham, Physician." London, 1550, 12°.

But from these times of ignorance and barbarism, in which the fairest of sciences was converted to the most foolish of purposes, let us now turn to the contemplation of the first gleams of wisdom that darted through the clouds, when rent asunder by the inventors of systematical botany.

Conrad Gesner, at Zurich, and Cæsalpinus, at Rome, towards the end of the 16th century, entirely independent of each other, first conceived the idea of a regular classification of plants by their flowers and fruit, to which, as Dr. Smith has observed, "the very existence of botany, as a science, is owing." Upon this plan various systems have been framed by succeeding botanists. But before we enter upon this subject, it will be essential, in the first place, to understand the general anatomy of plants, and lastly, the nature and functions of their particular organs.

It will readily be admitted, that the most convenient mode of coming to a knowledge of the anatomy of vegetables is, to begin from their external covering, the *epidermis*, or cuticle. Various theories have been formed respecting its uses to the vegetable body, but physiologists have mostly agreed that it was designed as a guard against the injurious effects of the atmosphere upon the vital parts of plants, since this, as well as the human cuticle, is merely a dead substance. The infinite variety of appearances which the epidermis assumes in different plants is peculiarly striking. It is commonly transparent and smooth; sometimes it is hairy or downy; sometimes of so hard a substance, that even flint has been detected in its composition. Hence the Dutch rush, equisetum hyemale, serves as a file to polish wood, ivory, and even brass.

Under the cuticle is found a substance, which till very lately has been but slightly noticed by physiologists. This is the *cellular integument*, analogous to the rete mucosum of animals; it is, like that, of a pulpy texture and the seat of colour. It is commonly green in the leaves and stems, and is dependent for its hue on the action of light.

When the cellular integument is removed, the outer surface of the *bark* presents itself, which, in plants or branches that are only one year old, consists of one simple layer, often scarcely separable from the wood. In the branches and stems of trees it consists of as many layers as they are years old; the innermost of these is called the *liber*, or inner bark, in which the vital functions for the season are carried on, and in the meanwhile materials for the new liber are secreted and deposited on the inside; the latter is destined to perform the requisite functions in the ensuing spring, when the last year's liber is united and assimilated to the outer bark, as its predecessors had been. It appears also, from the experiments and observations of Duhamel, Hope, Knight, and others, that the liber deposits matter also for a new layer of wood. The bark owes its strength and tenacity to innumerable woody fibres, mostly longitudinal, though connected laterally, so as to make a kind of net-work. This reticulation is so perfect and beautiful in the daphne laghetto, or lace bark of the West Indies, that it may be stretched laterally into a kind of gauze, sometimes used for articles of ornamental dress. The bark contains, in appropriate vessels, the principal secreted fluids of trees in great perfection. Its medicinal virtues in many instances are familiar to us; the Peruvian bark affords "a cooling draught to the fevered lip;" while that of the cinnamon yields a rich cordial; that which is stripped from the oak is used for the purpose of tanning, for which several other kinds are of inferior utility. When a wound is made in the bark, it heals, though slowly, by the lateral extension of the portion which is left.

Immediately under the bark is situated the *wood*, which forms the great bulk of trees and shrubs. This also consists of numerous layers, as any one must have observed in the fir and many other trees. Each of these layers is moreover composed of other thinner ones; their substance consists of innumerable woody fibres, and is perforated by longitudinal sap-vessels, variously constructed or arranged in different trees, and intermixed with other vessels containing secreted fluids or air.

It would be superfluous to enlarge on the economical uses of wood in every country, from the most barbarous to the most refined. Of this material the savage forms his club and his spear, while the civilized part of mankind convert it to the purposes of comfort and luxury. Many conjectures have arisen among philosophers, with respect to the manner in which the circular layers of wood are annually formed, and the effects which heat or cold may have on their formation. Cold seems to condense the operation, as well as for a time to interrupt it; since in the trees of hot countries these rings or layers are scarcely perceptible. In many trees more or less of the outermost layers continue for a time of a different colour and texture from the inner ones, and are called by workmen the sap. Such layers are unfit for any lasting service. The laburnum shews them very distinctly, and the oak likewise. It was long a matter of great uncertainty, how, or whence, each new layer of wood was added to the former ones. Malpighi and Grew, the first physiologists who gave attention to the subject, formed, without any mutual communication, an opinion, which proves to be correct, and to which we have already alluded, that the bark deposited every year from its own substance a new layer of wood. Hales thought this new layer proceeded from the wood of the former year; Linnæus presumed that it was secreted, internally, next to the pith. The experiments of Duhamel and Hope confirmed the sentiments of Grew and Malpighi; and at present there is no kind of doubt upon this subject. A layer of wood being formed every year, it is evident that the age of a sound tree may be known from counting its rings when felled; and it has been observed, that hard winters are recorded in this natural register by certain rings being more dense than the rest. In the north side of a tree also they are usually more narrow than on the south; and upon this principle a mode for travellers to find their way through an unknown forest has been suggested, namely, that by felling a tree they might ascertain the points of the compass; but we humbly conceive that much more obvious means for the same purpose are within the reach of every traveller, and that the one recommended is somewhat like telling

"——— That hour of the day
The clock doth strike by algebra."

Within the centre of the wood is the *medulla* or pith, which is a cellular substance, juicy when young, extending from the roots to the summits of the branches. In some plants, as grasses, it is hollow, merely lining the stem. Linnæus believed this part to be analogous to the nerves of animals, and the immediate cause of the growth and evolution of all their parts; that it was always struggling, as it were, to overcome the resistance of their woody substance, and that it did accordingly elongate itself, and cause the increase of the vegetable body in young and tender parts, where that resistance is least. The formation of seeds he conceived only put a final stop to its extension by the production of offspring from it. Facts are not wanting in support of this hypothesis; but there are many more conclusive ones against it. The real use and physiology of the part in question still remains in great obscurity.

OF ROOTS.

In defining the parts of vegetables, it is found most commodious to begin from the bottom, proceeding upwards. Hence the *root*, which is the first part produced by a germinating embryo, comes first under consideration. Its presence seems necessary to plants, as it serves to fix and hold them in the earth, from which they imbibe nourishment through their elementary tubes. Sea-weeds, however, afford an exception to this, for they are nourished by their surface, the root serving only to fix them to a convenient spot.

A root is either annual, biennial, or perennial. The first kind live but one season, as barley; the second survive one winter, and perish at the end of the following summer, after perfecting their seed, like wheat; if, however, any circumstances should prevent their flowering, they may live several years till that event takes place. Perennial roots are such as remain and produce blossoms for an indefinite term of years, like those of trees and shrubs in general, and of many herbaceous plants whose stems are annual.

The body of the root is denominated *caudex*; the fibrous, which is the only essential part, *radicula*. This latter is strictly annual in all cases, and is what serves for absorbing the nutritious fluids of the soil. It is necessary for the botanist, as well as the farmer and gardener, to be well acquainted with the several kinds of roots, which differ materially in their nature and functions. Those of a fleshy nature most powerfully resist drought, and are, as Dr. Smith has suggested, reservoirs of the vital energy of the vegetable. We have, with the permission of this gentleman, adopted in the following pages those leading ideas upon the subject before us, which are detailed and exemplified more at length in his "Introduction to Physiological and Systematical Botany," to which work we must refer those of our readers, who wish for more deep information than our limits will allow.

Roots are distinguished as follows:

1st. A fibrous root, *radix fibrosa*, consists entirely of fibres, as in many grasses, and a number of annual herbaceous plants. These can but ill bear a continued deprivation of moisture or nourishment. The fibres carry what they absorb directly to the base of the stem. Botany, Plate I. fig. 1.

2nd. A creeping root, *repens*, is a sort of subterraneous stem, spreading horizontally in the ground, throwing out abundance of fibres, as in mint and couch-grass. Weeds furnished with such a root are amongst the most pernicious, being so difficult to eradicate. Nature, however, having furnished them with so powerful a mode of increase, is very sparing in the production of their seeds. Fig. 2.

3rd. A spindle-shaped root, *fusiformis*, is common in biennial plants, though not confined to them. The radish and carrot have spindle-shaped roots, producing numerous fibres for the absorption of nutriment. Such roots may be transplanted with great safety in the torpid season of the year. Fig. 3.

4th. An abrupt or stumped root *præmorsa*, like that of the primrose, is as it were bitten off; hence many plants furnished with it have obtained the whimsical name of devil's-bit. Fig. 4.

5th. A tuberous or knobbed root, *tuberosa*, a very important sort, appears under a great diversity of forms. In the potatoe it consists of fleshy knobs connected by common stalks or fibres; these knobs are biennial, formed in the course of one season, and destined to produce fresh plants the following year. This is the case with the oval or hand-shaped roots of the orchis tribe. Some herbs, indeed, have perennial knobs to their roots. Fig. 5.

6th. A bulbous root, *bulbosa*, consists of a kind of subterraneous bud, being either solid, as in the crocus; tunicate, as in the onion; or scaly, like that of the lily. Fig. 6. These roots, like the knobs above-mentioned, are reservoirs of nourishment, or rather of the vital powers, during the winter. After flowering and leafing their herbage and fibres decay, and the roots may then be removed or kept out of the ground for a time without any hazard. When fresh fibres are formed it is fatal to disturb them.

7th. A granulated root, *granulata*, agrees in physiology with the last, being a cluster of little bulbs or scales connected by a common fibre, as in the white saxifrage and wood sorrel. Fig. 7.

OF BUDS.

Buds of trees have a great analogy with the bulbs and knobs of the roots in herbaceous plants. In them the vital principle is latent till a proper season for its evolution arrives. For this reason buds are essential to the trees or shrubs of cold countries, and are formed in the course of the summer in the bosoms of their leaves. The plane-tree has them concealed in the base of its foot-stalk, which answers the purpose of protection. In most instances they are guarded by scales, furnished with gum or woolliness as an additional defence. Till buds begin to vegetate they very powerfully resist cold, and are scarcely known to suffer at any season; but it is quite otherwise when they have made ever so slight an effort to develope themselves. Plants are propagated by buds as commodiously as by roots. Those of one tree may be engrafted on the bark of another of the same species, or one nearly akin, by which, as is well known, valuable varieties are multiplied. Fig. 8.

It is remarkable that nature should permit such devastation and waste as is made by many insects, whose caterpillars or grubs feed on the buds of trees. Several species of fir are infested with their appropriate insects, which, literally speaking, devour their vitals, and should seem to be capable in one season of destroying a whole forest. Yet these are only instruments in the hand of Providence, which, like many others, though formidable in appearance, are never allowed to transgress their due bounds.

OF THE STEMS AND STALKS OF PLANTS.

Botanists reckon seven kinds of stems or stalks of plants.

1. *Caulis*, a stem, fig. 9. properly so called, bears both leaves and flowers, as the trunks and branches of all trees and shrubs, as well as of many herbaceous plants besides. By its means the organs of plants are raised to a commodious height above the ground, and presented in various directions to the atmosphere and light. In germination, it always takes a contrary direction to the root. As it advances in growth, it is either able to support itself, or twines round, or adheres to other bodies. Some stems creep on the ground, and take root here and there, by which the plant is increased. The stem is either simple, as in the lily, or branched, as in the generality of plants. When regularly and repeatedly divided, with a flower springing from each division, it is called *caulis dichotomus*, a forked stem. Though generally leafy or scaly, a stem may be naked in plants destitute of leaves altogether, as the creeping cereus, and the genus staphelia. Climbing stems are of several kinds; as *radicans*, clinging to any other body for support, by means of fibres which do not imbibe nourishment; *scandens*, climbing by means of spiral tendrils, like the vine and passion-flower; *volubilis*, twining round any thing that comes in its way by its own spiral form, either from left to right, according to the apparent motion of the sun, like the honeysuckle, or from right to left, like the convolvolus and French bean; nor can any art or force make a twining stem turn contrary to its natural direction. In the manner of their growth and branching stems are very various, being either straight, irregularly spreading, or zigzag: either alternately branched or oppositely; two-ranked, when the branches spread in two horizontal directions, or brachiate, four-ranked, when they spread in four directions, crossing each other alternately in pairs. *Caulis determinate ramosus*, an abruptly branched stem, belongs particularly to the heaths, the rhododendron, &c. and is a term invented by Linnæus to express their peculiar mode of growth; each of their branches, after terminating in flowers, throws out a number of fresh ascending shoots from just below the flowering part. The Indian fig has a remarkable jointed stem, whose ovate portions look like leaves; possibly the scales with which they are covered may be equivalent to leaves.

The shape of a stem is either round or two-edged, as in the everlasting pea, or with three, four, or more angles. Square stems are extremely common, and such generally bear opposite leaves. Several stems are winged, the angles being extended into leafy borders, as in thistles.

The surface of the stem is either smooth, rough, watry, viscid, bristly, hairy, downy, woolly, hoary, or glaucous.

It is either striated with fine parallel lines or more deeply furrowed; sometimes it is spotted with a purplish hue.

The inner part of the stem is either solid, in which case its centre is occupied with pith; or hollow, and lined with a white shining membrane, of which the hemlock is an example. When the stem is wanting, a plant is called *acaulis*, as is the case with the daisy and primrose. The nature of the stem agrees in many respects with the caudex, or body of the root, at least in trees and shrubs; for such are capable of being propagated by cuttings of their stem or branches, which, when planted, throw out roots. This is not the case, however, with annual stems. Linnæus calls the stems of trees roots aboveground. It is frequently indifferent which end of a cutting is planted in the earth; and the extremity of a branch bent down to the ground in most cases readily takes root, which circumstances confirm his idea.

The stem of several plants is subject to a disease, whence it becomes as it were compound or clustered, forming a broad flat figure, crowded with leaves or flowers at the extremity, and sometimes besprinkled with them at the sides. We have seen it in the ash, holly, broom, nasturtium, wall-flower, toad-flax, &c. A kind of pea is frequently cultivated in Norfolk with red and white flowers, and a tender eatable pod, called the top-knot pea, in which this variety of stem is regularly propagated by seed.

2. *Culmus*, a straw, or culm, fig. 10, is the peculiar stem of grasses, rushes, and such like plants. It bears both leaves and flowers, and in that respect comes under the denomination of a caulis; but is readily known by its habit, though difficulties attend its definition. In most grasses, corn, &c. it is jointed in a manner peculiar to itself, and then cannot be mistaken; but in common rushes, and some few grasses, it is destitute of joints. When these parts are bent, it is called geniculate, and such joints readily take root.

3. *Scapus*, a stalk, fig. 11, springs immediately from the root, bearing flowers and fruit, but not leaves, as in the primrose and cowslip. It is either simple or branched, naked or scaly. In the cyclamen it becomes spiral after flowering, and buries the seeds in the ground. Dr. Smith has found, contrary to the opinion of Linnæus, that a plant may sometimes be increased by its scapus, as in lachenalia tricolor, which occasionally bears bulbs on its stalk.

4. *Pedunculus*, the flower-stalk, fig. 12, springs from the stem or branches, bearing flowers and fruit, but not leaves. *Pedicellus* is a partial flower-stalk, or, in other words, the ultimate subdivision of a general one. The most common situation of a flower-stalk is axillary, originating from between a leaf and the stem, or between a branch and the latter. It is rarely opposite to a leaf, as in some species of geranium, and still more rarely intermediate between two leaves, as in some kinds of solanum. It is either terminal or lateral: solitary, clustered, or scattered; simple or branched. According to the various modes in which it is subdivided, several kinds of inflorescence are distinguished, to be mentioned hereafter. Sessile flowers are such as have no stalk. The flower-stalk is occasionally naked, or furnished with bracteas. Very rarely it bears tendrils.

5. *Petiolus*, the foot-stalk, fig. 13, is applied exclusively to the stalk of a leaf, and is either simple, as in all simple leaves, or compound, as in the greater part of compound ones. Sometimes it bears tendrils. It is generally channelled on the upper side, and more or less dilated at the base; in one or two instances the flower-stalk grows out of it, as in turnera. Leaves that have no foot-stalk whatever are called sessile. The sap-vessels are for the most part very conspicuous in foot-stalks, and their spiral coats are easily observed.

5. *Frons*, a frond. This term, which properly means a bough, is technically applied by Linnæus to express the stem, leaf, and fructification being united, that is, the leaf bears the flowers and fruit. The term is only used in the class Cryptogamia. Ferns which bear seeds on the back of their leaf are genuine instances of this, and it is applied to lichens, &c. Plate II. fig. 14.

7. *Stipes*, stipe, is the stem of a frond, fig. 15, or the stalk of a fungus, as in the common eatable mushroom. In the former instance it is very generally clothed with scales of a peculiar chaffy texture; in the latter it is very often invested by a ring, formed of the membrane which had previously covered their fructification.

OF THE LEAVES.

The leaf, *folium*, fig. 16 and 17, is a very general organ of vegetables, yet not absolutely necessary to all plants, for the stems and stalks occasionally perform its functions. What those functions are we shall in a compendious manner explain.

Leaves are generally so formed as to present a large surface to the atmosphere: when they are of any other hue than green, they are said in botanical language to be coloured. Their duration is for the most part annual, but in some trees and shrubs, they survive two or more seasons, and such plants being always in leaf are denominated evergreens. The internal surface of a leaf, is highly vascular and pulpy, and is clothed with a cuticle very various in different plants, but its pores are always so constructed as to admit of the requisite evaporation or absorption of moisture, as well as to admit and give out air. Light also acts through this cuticle in a definite manner. That air and moisture and light have considerable, and even the most important effects upon the leaves of plants, has long been known to those who have studied the subject; that heat and cold affect them is familiar to every one. The experiments of Hales, Bonnet, and others, have thrown much light upon the absorption and perspiration of leaves, while those of Priestley and Ingenhouz have explained their effects upon the atmosphere, and the manner in which air and light particularly act upon them. Leaves have a natural tendency to present their upper surface to the light, and turn that surface towards it, in whatever direction it is presented to them. When trees in leaf are nailed to a wall, and the position of their leaves is consequently disturbed, they soon recover their natural direction. Light evidently acts as a wholesome stimulus to their upper surfaces, and as a hurtful one to the under. When the latter is forcibly presented for a long period to its rays, destruction is the consequence. Leaves seem to require occasional repose from the action of light on their upper surface; for, when it is withdrawn from them, many leaves close or fold themselves together, as if in a state of relaxation, and spread themselves forth again at the returning beams of the morning. This is more especially the case with winged leaves, as those of the pea kind. Those of the white acacia, robinia pseudo-acacia, have been remarked by Bonnet to be over-excited by the sun of a very hot day, and to fold their upper sides together, in a manner directly contrary to their nocturnal posture. The effect of moisture upon leaves every one must have observed. By absorption from the atmosphere, they are refreshed, and by evaporation, especially when separated from their stalks, they soon fade and wither. Aquatic vegetables, whose leaves are immersed in the water, both absorb and perspire with peculiar facility. Anatomical investigations have shewn that the nutricious juices, imbibed from the earth, and become sap, are carried by appropriate vessels into the substance of the leaves. Mr. Knight, in his papers in the Philosophical Transactions, has demonstrated that these juices are returned from each leaf, not into the wood again, but into the bark. Hence a new and curious theory of vegetation has been established. It appears that the sap is carried into the leaves for the purpose of being acted upon by air and light, with the assistance of heat and moisture. By all these agents a most material change is wrought in its component parts and qualities, differing widely according to the diversity of the species. Thus the resinous, oily, mucilaginous, saccharine, bitter, acid, or alkaline secretions are elaborated. The heedless observer of a leaf is little aware of the wonderful operations constantly going on in its delicate substance, nor can the most enlightened philosopher explain more than a very small part of the chemical processes of which it is the immediate agent. It is scarcely necessary to observe how materially plants differ in the flavour and qualities of their leaves, all which must depend in a great measure on the operation of the leaf itself, for the common sap of plants, from which all their secretions are made, differs very little in plants whose qualities are very unlike to each other; those qualities depending upon the secreted fluids elaborated principally by the leaves.

The green colour of the organs in question is easily proved to be almost entirely owing to the action of light. Plants which grow in the dark are of a sickly white, which is the case with any parts artificially or accidentally covered with earth, as in cultivated cellery or asparagus, whose stems and leaf-stalks are purposely managed in this way, to render their flavour and appearance more delicate. Such blanched parts soon become green on exposure to light. Leaves are subject to a sort of disease, by which they become partially spotted or streaked with white or yellow. In this state they are termed variegated, and occasionally contribute to the ornament of our gardens. The whiteness frequently extends to the leaf-stalk, and sometimes to the branch, as may be seen in the variegated alder. Such varieties are propagated by cuttings, layers, or roots, but not by seed. They appear to be somewhat more tender than the plant in its natural state.

One variety of the holly has, in addition to a yellow variegation, a beautiful tinge of purple, but this is a rare instance. In the amaranthus tricolor the leaves are naturally adorned with most beautiful and splendid colours, and in some other species of the same genus with more uniform and less vivid tints.

The irritable nature of some leaves is remarkable, not but that all leaves may truly be said to possess irritability with respect to light. The phenomena however to which we now allude are of the most striking kind. The sensitive plant, mimosa pudica, common in hot-houses, when touched by any extraneous body, folds up its leaves one after another, while their foot-stalks droop as if dying. After a while they recover themselves again. Each leaf of the dionæa muscipula, or Venus's fly-trap, is furnished with a pair of toothed lobes, which, when touched near the base, fold themselves together, and imprison any insect that may be in their way. It is presumed that the air evolved by the body of the dead insect may be wholesome to the plant, for leaves are known to purify air impregnated with carbonic acid gas, produced from the breathing of animals or the burning of a candle. The sarracenia, of which several species from America are now cultivated in our more curious gardens, bears tubular leaves, which retain water in their hollows, and imprison insects, whose putrefying bodies evidently produce a quantity of bad air, and analogy leads us to suppose that air is destined to be serviceable to the constitution of the vegetable. See Dr. Smith's Introduction, page 195.

Many important botanical distinctions are founded upon the situations and forms of leaves. These are explained by the following terms.

Folia radicalia, are radical leaves, as in the primrose.

F. *caulina*, stem, leaves, and *ramea*, branched leaves. The situation of the latter is either alternate, opposite, scattered, or clustered. Several leaves standing round a stem or branch are termed *verticillata*, whorled; such as either ternate, quaternate, or quinate, &c.

F. *imbricata*, imbricated, lie one over the other like tiles upon a house.

F. *decussata*, cross each other in pairs alternately, as in many plants with opposite leaves.

F. *disticha*, two-ranked, spread in two directions like the yew.

F. *secunda*, unilateral, lean all towards one side. Some leaves are erect, others reflexed or recurved; but the greater part spread more or less horizontally. A few are obliquely twisted, and still fewer are reversed, *resupinata*, what should be the upper surface becoming the under, as in the beautiful alstræmeria. Curt. Mag. t. 139.

F. *petiolata* are such as stand on footstalks; *sessilia*, sessile leaves, grow immediately from the branch or root without any stalk.

F. *peltata*, peltate leaves, have the footstalk inserted into their centre, like the handle of a shield, to which the name alludes, witness the common nasturtium trapæolum.

F. *amplexicaulia* clasp the stem or branch with their base.

F. *decurrentia* run down the same part in the form of a leafy border, as in many thistles.

F. *connata* are united at their base.

F. *perfoliata* have the stem running through them, as in hair's-ear, bupleurum rotundifolium.

F. *vaginantia* sheath the stem on each other, as in most grasses.

F. *equitantia* clasp each other in two opposite rows, being compressed at the base, as in many common species of iris.

The form of leaves is either simple, as in grasses, lilies, &c. or compound, as in parsley, elder, roses, &c. Simple leaves are either *integra*, undivided, like those just mentioned, or lobed like the vine, holly-hock, and many others.

The following forms of simple leaves respect their outline only.

Folium orbiculatum, as nearly circular as possible, which is very rare.

Subrotundum, roundish, is much more common.

Ovatum, ovate, the shape of an egg, very frequent.

Obovatum, obovate, the same figure with the broad end uppermost.

Ellipticum, or *ovale*, elliptical, or oval, being broadest in the middle.

Oblongum, oblong, several times longer than broad, without any very decided form.

Spatulatum, spatulate, of a roundish figure, tapering into an oblong base.

Cuneiforme, wedge-shaped, broad at the summit, tapering down to the base.

Lanceolatum, lanceolate, narrow, and oblong, tapering towards each end, a very common sort of leaf, as in willows.

Lineare, linear, narrow, with parallel sides, like most grasses.

Acerosum, needle-shaped, linear, and

evergreen, generally acute, and rigid, as in the fir, juniper, &c.

Triangulare, *quadrangulare*, *quinquangulare*, express the number of angles, without any allusion to their measurement.

Daltoides, trowel-shaped, or deltoid, has three angles, of which the terminal one is the most acute.

Rhombeum, rhomboid, nearly square.

Reniforme, kidney-shaped, as that of the asarabacca.

Cordatum, heart-shaped, which is extremely common.

Lunalatum, crescent-shaped, whether the points are directed backwards or forwards.

Sagittatum, arrow-shaped, triangular, with the posterior angles much elongated.

Hastatum, halbert-shaped, triangular, the lateral robes spreading horizontally.

Panduriforme, fiddle-shaped, as in the fiddle dock.

Runcinatum, runcinate, or lion-toothed, cut into several transverse acute reflexed segments, like the dandelion.

Lyratum, lyrate, or lyre-shaped, cut into several transverse segments, gradually larger towards the extremity of the leaf, which is dilated and rounded.

Fissum, cloven, when the fissures are linear or straight.

Lobatum, lobed, when the segments are rounded.

Sinuatum, sinuated, cut into rounded, dilated openings.

Partitum, deeply divided, almost to the base.

Laciniatum, laciniated, cut into various irregular portions, as if torn.

Incisum, and *dissectum*, express somewhat of a more regular kind of division.

Palmatum, palmate, cut into several oblong segments, leaving an entire space at the base.

Pinnatifidum, pinnatifid, cut into several transverse parallel segments.

Bipinnatifidum, doubly pinnatifid.

Pectinatum, pectinate, pinnatifid, with remarkably narrow segments, like the teeth of a comb.

Inequale, unequal or oblique, when the two halves of a leaf are unequal, and their bases not parallel.

A leaf in its termination is either *truncatum*, abrupt; *premorsum*, jagged-pointed, having various irregular notches, as if bitten; *retusum*, ending in a broad shallow notch; *emarginatum*, with a small acute notch; *obtusum*, ending in a segment of a circle; *acutum*, terminating in an acute angle; *acuminatum*, having a taper point; *obtusum cum acumine*, blunt, with a small point; *mucronatum*, or *cuspidatum*, tipped with a spine; or *cirrosum*, tipped with a tendril.

A leaf, with regard to its margin, is either *integerrimum*, entire, as in the lilac; for it must be observed, that *integrum* means an undivided leaf; *spinosum*, beset with prickles, as in thistles, which is opposed to *inerme*; *ciliatum*, fringed with soft hairs; *cartilagineum*, hard and horny; *dentatum*, toothed; *serratum*, serrated, the teeth like those of a saw, pointing forwards; *serrulatum*, minutely serrated; *crenatum* and *crenulatum*, notched with little rounded scallops, as in ground ivy; *erosum*, jagged; *repandum*, wavy; *glandulosum*, glandular; *revolutum*, having the margin turned or rolled backwards, of which *involutum* is the reverse; or *conduplicatum*, having the margins folded together.

A leaf, as to its disk, is either *rugosum*, rugged; *bullatum*, blistery; *plicatum*, plaited, like a fan; *undulatum*, waved obtusely up and down; *crispum*, elegantly curled and twisted, which is generally a preternatural luxuriance; *concavum*, hollow in the middle; *venosum*, veiny; *nervosum*, ribbed, the principal veins or ribs extending in simple lines from the base to the point; *avenium*, without veins; *enerve*, without ribs; *trinerve*, three-ribbed; *triplinerve*, triply-ribbed, when the lateral ribs branch off above the base; *basi trinerve*, when the base is cut away close to the lateral ribs, as in burdock.

A few other terms relating to leaves in general deserve mention. F. *carnosum* is a fleshy leaf, such as belongs to those called succulent plants. The internal pulp of these seems to have no share in their peculiar functions as leaves; but to be a reservoir of moisture, and some degree of vitality. F. *nudum* means a leaf destitute of all clothing or hairiness whatever: the same term applied to a stem means that it bears no leaves, and to a flower, that it has no calyx. F. *tubulosum* is a tubular leaf, as in several species of allium; *lobelia dortmanna* has a leaf formed of a double tube; *canaliculatum* expresses a leaf with a longitudinal furrow; *carrinatum*, one with a prominent line like a keel at its back; *ensiforme*, the sword-shaped or two-edged leaf of the irises; *alcinatum*, is used by Dr. Smith, "when the first leaves of a plant give place to others totally different from them, and from the natural habit of the genus, and in many mimosæ of New Holland;" the first leaves of these are pinnated, the subsequent ones dilatations as it were of the naked foot-stalks; *appendiculatum* is used by the same author for a leaf "furnished with an additional organ for some particular purpose," as in dionæa muscipula above mentioned, and nepenthes destillatoria, the leaf of which bears a sort of covered pitcher full of water. We omit to particularize the more common terms which are to be found every where.

Compound leaves come principally under the following denominations.

F. *digitatum* is when several leaflets, or partial leaves, stand on the summit of a common foot-stalk. Such are either two, three, or more. F. *pinnatum*, a pinnate leaf, is composed of leaflets ranged laterally on the foot-stalk; when it has no terminal leaflet, it is said to be abruptly pinnate; sometimes a tendril takes place of the odd leaflet, as in the pea and vetch. The leaflets are either opposite or alternate; sometimes they are interrupted by an intermediate series of smaller ones, as in spiræa filipendula, dropwort. F. *lyratopinnatum* resembles a lyrate leaf, as in the turnip. F. *auriculatum* is a simple leaf, with a pair of auricles or leaflets at its base. F. *pedatum* has three primary leaflets, of which the lateral ones are lobed in their fore part, as in helleborus fœtidus. The different degrees in which leaves are compounded are thus expressed. F. *compositum* is simply compound; *decompositum*, doubly compound: *supra decompositum*, thrice compound, or more; of all which the umbelliferous tribe afford examples; *bigeminatum* and *tergeminatum* are twice and thrice paired; *ternatum* consists of three leaflets: *biternatum* is twice ternate, and *triternatum*, thrice ternate. In the same manner, *pipinnatum* is doubly pinnate, and *tripinnatum* triply pinnate.

OF THE FULCRA, OR APPENDAGES OF PLANTS.

There are various appendages to the herbage of plants, all of which are comprehended by Linnæus under the term of *fulcrum*, a prop or support, which term, in its literal sense, however, applies but to a few of these organs.

1. *Stipula*. This is a leafy appendage to the true leaves, or to their stalks, for the most part in pairs, more or less constant even in the same genus or species: in roses they are invariable; in willows very much the contrary. Some species of Cistus have stipulas, others none. The peculiar stipula of grasses is a membrane, crowning the sheaths of their leaves and embracing their stem, but it is not found in all the species. Plate 1. fig. 18.

2. *Bractea*, is a leafy appendage to the flower or its stalk, conspicuous in the lime-tree, beautifully coloured in the purple or pink-topped clary, and very much diversified in different plants. Fig. 19.

3. *Spina*, a thorn, proceeds from the wood itself, as in the wild pear-tree, which loses its thorns by cultivation. This is fancifully expressed by Linnæus, who calls such garden plants tamed, or deprived of their natural arms.

4. *Aculeus*, a prickle, proceeds from the bark only, having no connection with the wood, as in the rose, bramble, &c. It might be expected that this should be less permanent than the foregoing, but the reverse is the case, for prickles are not effaced by culture. They rather abound most upon the most luxuriant stems. Plate II. fig. 21.

5. *Cirrus*, a tendril or clasper, is really intended as a support for weak stems, by which they are enabled to climb rocks, or the trunks of lofty trees. These organs are either simple or branched, straight in the first instance, but soon becoming spiral, and thus are rendered capable of taking hold of any thing that comes in their way; especially as many of them are so constructed, that after having made a certain number of turns, they perform as many in a contrary direction. Some attach themselves by a dilatation of their extremities to the smoothest and hardest stone. Thus, the vine, the passion-flower, and the family of vetches, are elevated to a considerable height above the ground. Such tendrils differ essentially from roots, in never imbibing nourishment, any more than the short fibres of the ivy. The gloriosa, or superb lily, has a spiral tendril at the end of each leaf, and in some few plants the flower stalks produce tendrils. Plate I. fig. 22.

6. *Glandula*, a gland, is a small tumour secreting a sweet, resinous, or fragrant liquor, as on the calyx of the moss-rose, the foot-stalks of passion-flowers whose glands are like little cups, and the leaf of salix pentendra: which last being pressed between paper, leaves the impression of an elegant row of yellow dots. Fig. 23.

7. *Pilus*, a hair. Fig. 24. Under this are included all the various kinds of pubescence; bristles, wool, &c. some of which are curious objects for the microscope. Some few of these bristles discharge a poison, as in the nettle, causing great irritation, whenever they are touched in such a manner as for their points to

wound the skin. Hence arose the following lines:

"Tender-handed touch a nettle,
And it stings you for your pains;
Grasp it like a man of mettle,
And it soft as silk remains."

OF THE DIFFERENT KINDS OF INFLORESCENCE, OR MODES OF FLOWERING.

The various modes in which flowers are situated upon or connected with a plant, are of great botanical importance, not only for specific distinctions, but as leading the way to a knowledge of natural families or orders. Yet Linnæus does not allow them to enter into the generic characters of plants, which he founds solely on the seven parts of fructification to be hereafter described. This is one of those classical maxims of the Linnæan school, which rival botanists are continually attempting to undermine and depreciate, conscious of their own deficiency in that technical skill for which Linnæus was pre-eminent. We shall take occasion to mention an instance in which he himself went counter to this law.

The following are the several kinds of inflorescence.

1. *Verticillus*, a whorl, in which the flowers surround the stem in a garland or ring, though perhaps merely inserted on its two opposite sides, as in the natural order to which the mints, the dead nettle, Lamium, and many others, belong. Fig. 25.

2. *Racemus*, a cluster or raceme, bears several flowers, each in its own stalk, loosely ranged along one common stalk, like a bunch of currants, and this common stalk may be either simple or branched. A racemus is generally drooping or pendulous, and the flowers are all nearly in perfection at once. Fig. 26.

3. *Spica*, a spike is composed of numerous crowded flowers, ranged along an upright common stalk, expanding progressively and properly, destitute of any partial stalks; but this last circumstance cannot be rigidly observed. Wheat and barley are good examples of a genuine spike. Some lavenders have a compound spike. *Spicula*, a spikelet, is a term used only for grasses, and expresses that assemblage of florets in a common calyx which constitutes their flowers. Fig. 27.

4. *Corymbus*, a corymb, fig. 28, may be called a flat-topped spike, the long stalks of whose lowermost flowers raise them to a level with the uppermost, or nearly so; this is exemplified in the cabbage and wall-flower. The yarrow and mountain-ash bear a kind of compound and irregular corymbus, to which is nearly allied,

5. *Fasciculus*, a fascicle, expressive of a close bundle of flowers, on little stalks, variously connected and level at the top, as in the sweet-william. Fig. 29.

6. *Capitulum*, a head or tuft, is composed of numerous sessile flowers, collected into a globular form, as the globe amaranthus and thrift. Fig. 30.

7. *Umbella*, an umbel or rundle, consists of several stalks, called rays, spreading from one common centre, like an umbrella. Each stalk is either simple and single-flowered, or, as most commonly occurs, subdivided into an *umbellula*, or partial umbel. This inflorescence belongs to a natural order, thence called *Umbellatæ*, to which the parsley, carrot, hemlock, and many others belong. Fig. 31.

8. *Cyma*, a cyme, consists of stalks springing from one common centre, but which are afterwards irregularly subdivided, as in the laurustinus and alder, fig. 32. Linnæus was led by some considerations to reckon these two last forms of inflorescence as aggregate flowers, but it is found more correct to esteem them modes of inflorescence, though by so doing we lose the advantage of taking parts properly belonging to the umbel into the generic character. By a contrary mode of proceeding we presume to think Linnæus swerved from his own rule of founding his genera on the actual parts of fructification.

9. *Panicula*, a panicle, Plate III. fig. 33. is a loose subdivided bunch of flowers, arranged without order, as in the oat. It is either close or spreading. When its branches lean all towards one side, it is called *Panicula secunda*.

10. *Thyrsus*, a bunch, is a very dense panicle, inclining to an ovate figure, of which Linnæus cites the lilac and the butterbur as instances. Dr. Smith adds to these a bunch of grapes, which appears to him to have been inaccurately reckoned a racemus. Fig. 34.

OF THE FRUCTIFICATION OF PLANTS.

Under the term fructification are comprehended, not only all the parts of the fruit, but also those of the flower, which last are indispensable for the perfecting of the former. All these organs are, therefore, essential to a vegetable, which may be deficient in any of those that we have previously described, but can never be totally destitute of those by which its species is propagated from generation to generation; for propagation by cuttings, buds, or roots, is only the extension of an individual, the life and vigour of which gradually wears out, unless it be reproduced from seed. The fructification is, therefore, well defined by Linnæus as "a temporary part of vegetables, terminating the old individual and beginning the new."

The parts which constitute these essential organs are seven. 1. *Calyx*, fig. 35, the flower cup, or external covering of the flower. This also is of seven kinds. 1. *Perianthium*, or calyx, properly so called when it is contiguous to and makes a part of the flower, as the five green leaves which encompass a rose, including their urn-shaped base. 2. *Involucrum*, which is remote from the flower, as in the umbelliferous tribe; but if the idea of these plants as above expressed be just, the part in question ought rather to be considered as a *bractea*. 3. *Amentum*, a catkin, is formed of numerous scales attached to one cylindrical receptacle, and falling off with it: in catkins which bear seed the scales are often enlarged, and hardened into a cone, as in the fir. 4. *Spatha*, a sheath, bursts longitudinally, and is more or less remote from the flower, as in the snow-drop, narcissus, and arum. 5. *Gluma*, a husk, is the peculiar chaffy calyx of grasses and their allies: to it belongs the arista or awn, which however is not constant in the same species of grass or corn: an elegant feathery awn is seen in the stipa pennata, feather-grass. 6. *Perichætium*, a scaly sheath, investing the fruit-stalk in some mosses, as hypnum. 7. *Volva*, the wrapper of the Fungus tribe, is either of a membranous kind, sheltering their fructification, as in the common mushroom, or more coriaceous, investing the base of their stalk, as in many fungi.

2. *Corolla*, fig. 36, the delicate, generally coloured, leaves of a flower are always situated within the calyx, when both are present. This term comprehends both the petal, *petalum*, and the nectary, *nectarium*. A flower consists of one petal, or of several, the former, denominated monopetalous, is either campanulate, funnel-shaped, salver-shaped, wheel-shaped, ringent like the mouth of an animal, or personate, closed by a palate. Its parts are the tube and the limb. A polypetalous corolla is either cruciform, as in a wall-flower, rosaceous, papilionaceous, as in the pea kind, or incomplete, when some parts found in analogous flowers are wanting. The parts of a polypetalous corolla are the claw and the border. The great point to be considered with respect to the corolla in general is, whether it be regular or irregular; in some flowers, however, it varies in the same species from one shape to the other, witness the genera antirrhinum and bignonia.

Neither the calyx nor corolla is indispensably necessary to a flower. Both are wanting in hippuris, and one or other is deficient in many genera. Hence botanists are led into a perplexity how, in some cases, to denominate the part which is present. When its green colour and thick texture agree with the generality of flower cups, we do not hesitate to esteem it such; but a calyx is often beautifully coloured, and there is some doubt whether the splendid leaves of tulips and lilies be not a true calyx; at least they answer to the Linnæan definition, that their parts are opposite to the stamens, whereas those of a corolla should be alternate with the latter. The Linnæan hypothesis, however, though sanctioned by Jussieu, of the corolla proceeding from the inner bark, and the calyx from the outer, is entirely subverted by recent and more correct observations on vegetable physiology. The functions of these two parts are, perhaps, though similar, not exactly analogous. Those of the calyx probably resemble what are performed by the leaves, and this part is presumed by Dr. Smith even to secrete woody matter, for strengthening the fruit-stalk. The corolla, indeed, seems destined to answer some exclusive purpose to the essential organs of impregnation with regard to air and light. It fades when they wither, and is altogether of temporary duration.

Nectarium, the nectary, fig. 37, is frequently a part of, or an appendage to, the corolla; sometimes the petal itself secretes honey: sometimes a set of glands perform this function; and in other cases there is a peculiar petal-like apparatus for preparing or holding the nectarious juice. Linnæus has remarked that plants, whose nectary is distinct from the petals, are commonly poisonous, which in general holds good with those of the more elaborate nectaries. A German writer, named Sprengel, has proved the corolla to be in many instances an attraction, as well as accommodation, for insects in their search after honey: he remarks certain spots, called by him *maculæ indicantes*, which he conceives are designed to direct these little animals to their prey. The scent of flowers may perhaps contribute to the same end. There can be no doubt that the use of the honey is to attract insects, to promote the impregnation of the flower, and not, as some have thought, for the nourishment of the seeds or other organs, being frequently quite out of the reach of both.

3. *Stamina*, fig. 38, the stamens, are situated withinside of the corolla, and are various in number in different flowers, from one to several hundreds. These are the essential organs of impregnation. A stamen usually consists of two parts, *filamentum*, the filament and *anthera*, the anther, the latter of which only is essential. Its most common shape is oblong, composed of two cells or cavities, which burst by a longitudinal fissure on the outside. A more unusual structure is when the anther opens by pores towards the summit, as in the genus erica, or heath, of which such a profusion of beautiful species from the Cape of Good Hope enriches our green-houses. Some of their anthers, moreover, are furnished with variously formed and very elegant crests and spurs, which afford the botanist marks for discriminating the species. The genus of first, Pinus, has a jagged crest to its anthers, which serves also to distinguish some of the difficult species from each other. The situation of anthers upon their filaments is either pendicular or incumbent. Some of the latter kind are versatile, being suspended by a fine thread, which admits of their being turned round a great number of times without coming off. This may be seen to great advantage in the passion-flower, as likewise in the different species of lily. The cells of the anther are destined to contain the pollen, or dust. This appears to the naked eye like a fine powder; but when examined under the microscope, it is often found to have a very peculiar structure in different plants. It is discharged chiefly in dry sunny weather, when either the coats of the anther, by bursting, scatter it abroad, which is often assisted by some elasticity of the filaments or other parts of the flower; or else it adheres to the rough bodies of insects, as they frequent the flowers in search of honey. Each grain of the pollen remains entire so long as it continues dry, being a membranous bag, so constructed as to burst when it meets with moisture, discharging a fine elastic vapour, and this last is the effective part of the pollen. This is the general appearance of the substance we are describing; but in the orchis family, the mirabilis, the asclepias, and some of its allies, the pollen is remarkably different, consisting of glutinous naked masses, sheathed inside, or concealed by the peculiar structure of the flowers; but scarcely, except in the mirabilis, lodged in a proper anther. The stamens are subject to be obliterated when the plant increases much by root; they are metamorphosed into petals in what are called double flowers, as the anemone and ranunculus, so much admired by curious florists.

4. *Pistilla*, the pistils, fig. 39, are also an essential part of a flower, standing within the circle formed by the stamens in the very centre of it; at least, they are usually in the same flower with the stamens. Sometimes they are placed in a different individual of the same species. Such are termed separated flowers. That furnished with stamens being called the male or barren blossom; that with pistils the female or fertile one. Such as have both organs in the same individual have received the appellation of united or perfect flowers; and here it may not be amiss to mention, that a flower furnished with both calyx and corolla is, in Linnæan language, said to be complete; when the corolla is wanting, incomplete; and when the corolla is present without the calyx, naked. When barren and fertile flowers are borne by the same individual plant, such are named monoecious, as residing in the same house. If, on the other hand, they grow from two separate roots, they are dioecious. Some plants, besides these different kinds of flowers, bear others, in which the organs are associated. To these the term polygamous has been applied. Each pistil consists of three parts, the germen, or rudiments of the future fruit or seed, which is of course essential; the style, which is not universal; and the stigma, which is necessarily so, being the part destined to receive the pollen, and being furnished with its own appropriate moisture, to make that substance explode. By this means the seeds within the germen are rendered fertile. In some plants the stigma has been observed to be irritable, and in others to gape for the reception of the pollen. In general it remains vigorous no longer than till the pollen has had access to it. It is necessary for botanical purposes to observe, whether the germen be superior, that is, above the calyx and corolla, or inferior, below their insertion. Pistils as well as stamens are occasionally obliterated or changed to petals.

5. *Pericarpium*, the seed-vessel, for which some recent cryptogamic botanists have contrived a new term, *sporangium*,

precisely of the same meaning, and altogether superfluous. The seed-vessel is formed of the germen enlarged, and is not an essential part; for many plants have naked seeds, guarded only by the permanent parts of the flower. The wisdom of nature is very conspicuous in the contrivance of seed-vessels in general; some, which remain closed while they are moist, split open with elastic force when ripe and dry; others serve for the food of animals, by whose means their seeds are transported to a distance; others make their way into the ground, by some peculiar apparatus, near the spot where they are produced; while others are wafted by the winds or transported by the waters to far distant situations. The following are the different kinds of seed-vessels:—1. *Capsula*, a capsule, fig. 40, is dry and woody, coriaceous or membranous, of one or more cells, opening and discharging its contents by valves or by pores. 2. *Siliqua*, a pod, fig. 41, is a long, dry, solitary, seed-vessel, of two valves, and divided into two cells by a linear partition, along each of whose edges the seeds are ranged; of this the wall-flower and stock are examples. *Silicula*, a pouch, is a small round pod. 3. *Legumen*, a legume, fig. 42, is the fruit of the pea kind, solitary, formed of two oblong valves, without any longitudinal partition, and having the seeds ranged along one of its margins only. 4. *Drupa*, fig. 43, a stone-fruit, like the peach and cherry, has a fleshy undivided coat, containing a single hard stone or nut. 5. *Pomum*, fig. 44, an apple, contains a capsule of several cells in a fleshy coat. 5. *Bacca*, fig. 45, a berry, is fleshy, without valves, containing one or more seeds lodged in pulp, as the goose-berry and currant. Some berries are compound, as the raspberry; others are of a spurious kind, the pulp originating from some part not properly belonging to the fruit, as the calyx in the mulberry, and the receptacle in the strawberry. And, fig. 46, *Strobilus*, a cone, originates from a catkin, become hardened, and enlarged into a compound seed-vessel, as in the fir, birch, &c.

6. *Semina*, the seeds, fig. 47, the most essential of all the organs of fructification, being those to which all the others are subservient. The seeds are composed of several parts, the most important of which is the *embryo*, or germ. Linnæus calls it *corculum*, a little heart, in allusion to its shape in the walnut, in which, as well as in the bean, and other leguminous plants, it is readily observed. Its position is either upright, horizontal, or reversed. It is generally lodged within the substance of the seed, except in grasses. *Cotyledones*, the cotyledons, or seed-lobes, are intimately connected with the embryo; they are almost universally two in number, though in the fir tribe they are more numerous. When the seed has sent its root into the ground, these organs generally rise above the surface, and perform the functions of leaves till the proper foliage is produced. Plants, therefore, for the most part, are properly denominated *dicotyledones*. Such as are called *monocotyledones* have really no proper cotyledon, and the first part that appears above the ground from their seed is a real leaf. *Albumen*, the white, makes up the chief bulk of some seeds; but never rises out of the ground, nor assumes the office of leaves, being destined solely to nourish the embryo till its roots can perform their office. It may be observed in grasses, corn, and palm-trees: in some it is farinaceous; in others as hard as a stone; witness the date. The nutricious matter, which in these plants constitutes the albumen, is in others lodged in the substance of the cotyledons. *Vitellus*, the yolk, was first named by Gærtner, and is supposed by him to furnish nourishment to the embryo. Dr. Smith, however, has first suggested, that the *vitellus* is rather a subterraneous cotyledon, see his "Introduction to Botany," 292. *Testa*, the skin, a single or double membrane envelops the parts hitherto described, bursting irregularly when its contents swell in germination. *Hilum*, the scar, is the point of attachment through which nourishment is conveyed to the seed while growing. This point is always considered as the base of the seed in description.

Seeds are often accompanied by appendages or accessory parts, as *pellicula*, the pellicle, which adheres to their outside in the form of a fine skin, sometimes downy, sometimes of a mucilaginous substance. An instance of the latter occurs in Salvia verbenaca, whose seeds are celebrated for extracting particles of dust from the eye, by enveloping them in its mucilage, which swells on the application of moisture. *Arillus*, the tunic, is a complete or partial covering of a seed, fixed to its base only, and more or less closely enfolding its other parts. In the euonymus it is pulpy and orange-coloured, the seed itself being crimson. The mace, which enfolds the nutmeg, is of this nature. Many of the orchis tribe are enveloped in a membranous tunic, extending beyond the outline of the seeds, and giving them a light chaffy appearance. The elegant wood-sorrel has an elastic arillus, like a little bag, serving to project the seeds to a distance. In the carex the same part is in some degree inflated and membranous. The covering of the seeds in the cynoglossum is considered by Dr. Smith as a *testa*, rather than an arillus. *Pappus*, the seed-down, in its most strict sense, is the chaffy, feathery, or bristly crown of several seeds that have no seed-vessel, as in the dandelion, thistle, scabious, and others. In a more general sense, pappus is applied to any feathery or downy appendage to seeds, even though lodged in a pericarpium. *Cauda*, a tail, is an elongated appendage, originating from the permanent style. It is generally feathery, as in the virgin's bower, clematis. *Rostrum*, a beak, has a similar origin, but usually belongs to a seed-vessel. *Ala*, a wing, is a dilated membranous appendage, serving to waft seeds along in the air. To all the above may be added various spines, hooks, scales and crests, generally serving to attach such seeds as are furnished with them to the rough coats of animals, and so to promote their dispersion. This appears to be the final purpose of the awns of grasses in general.

6. *Receptaculum*, fig. 48, the receptacle, is the common base or point of connection of the parts of fructification. It is essential, inasmuch as it must exist in some form or other. This part, however, comes chiefly into notice when it assumes any peculiar form, as in compound flowers; the dandelion, daisy, and thistle, for instance. In some of this class it is naked, scaly, hairy, or cellular, and such circumstances afford excellent generic characters. Such of the natural order of Proteaceæ as have aggregate flowers are also furnished with as conspicuous a receptacle as the compound flowers. The receptacle of the seeds is a term used for the part to which they are attached in a seed-vessel.

OF THE CLASSIFICATION OF PLANTS.

The species of plants, as well as of all other natural productions, are so immensely numerous, that the most superficial observer must be aware of the necessity of some regular mode of arranging them, as well as of naming and distinguishing them, in order to acquire or to retain any clear knowledge of their natures, differences, or comparative uses. Hence the distribution of plants into trees, shrubs, and herbs, into eatable, medicinal, or hurtful kinds, was very early conceived; for the human mind is naturally prone to method and combination. When the subject came to be scientifically studied, various plans were formed, as different in ingenuity and utility as possible, proceeding on various principles, but all aiming at the same end, the commodious arrangement of plants. The authors of these various schemes seem all, as far as they considered the matter with any such view, to have thought their own plan most consonant with that natural classification which every one at first sight perceived to exist in the creation; but a little experience proved that the clue of nature soon eluded their grasp.

Linnæus, the first person who took a very comprehensive and philosophical view of the laws of system, and at the same time carried them most happily into effect, for the purposes of utility and facility, was the first to perceive the difference between a natural arrangement and an artificial one. He ever considered the former as the great desideratum of philosophical botany, and indeed as necessary to be kept in view by all who describe or define new discovered plants; while the latter was to be adopted for ready use and convenience, just as words are arranged in a dictionary according to their spelling, without any regard to their derivations or analogical meanings. The same great naturalist was also, from the first, aware of the essential importance of the principle laid down by Gesner and Cæsalpinus, as we have already stated, that plants ought to be arranged by their parts of fructification alone, and not by their general habit or structure independent thereof. Hence he denominates heterodox, all such systematics as class vegetables by their leaves, roots, uses, times of flowering, or places of growth, for, strange to tell! there have been such; and he esteems truly orthodox, those botanists only who derive the characters of their systems from the flower and fruit, in which, as he expresses it, the true form or essence of their being is displayed. On this point all botanists are now agreed, but they differ widely concerning the eligibility of a natural or an artificial system for daily use, as well as the principles upon which each ought to be founded.

The earlier systematics began with the consideration of the seed and seed-vessel, forming their classes upon the situation of the embryo, whether at the top or base of the seed, and the number of the seeds and seed-vessels, or their cells, in different plants. Some, as the great English naturalist, Ray, took into consideration, over and above the fruit and its parts, the form and number of the parts of the corolla, and even the leaves and roots, which altogether make but a motley jumble of principles; but in a second attempt, this learned man was more uniform and successful in his scheme. Others founded their systems on the corolla alone, as Rivinus and Tournefort, whose methods are elegant and attractive at first sight, but far more unphilosophical, far more difficult in practice, than those founded on the fruit. The authors of these various systems disputed with great warmth concerning their respective merits, and each had his followers and advocates. Many other methods were contrived, partaking, more or less, of the principles of the few great leading systematics who contended for the botanical sceptre, and frequently borrowing from them without due acknowledgment. All these systems have now passed away, at least with respect to practical use. They are the study of the botanical antiquary, and they are instructive to the student of philosophical arrangement in general; but no work that treats of plants is arranged by their laws, nor does any practical botanist waste his thoughts or judgment in comparing their different merits.

Two systems at the present day divide the botanical world between them, the artificial one of Linnæus, and the natural one of Jussieu. Yet it can be only those who are very unphilosophical, or ignorant of the subject, or who have some sinister purpose to serve, who bring these systems into competition as rivals. They are in fact allies and mutual supports, and it is the opinion of an experienced botanist (Dr. Smith) of the present day, that in the actual state of the science, perhaps neither of these systems can stand alone. Plants are so numerous, and those of their parts upon which all systems depend so liable to variations and irregularities, that neither the Linnæan system, nor any other artificial one, however simple and comprehensive its principles, can conform to them all with sufficient precision to be in any degree infallible. On the other hand, every natural system is necessarily so incomplete, for want of an uniformly perfect knowledge in its contriver of all the plants in the world, and of their mutual dependencies on each other, as well as of the best possible manner of defining and characterizing the classes and orders in which human contrivance is obliged to dispose them, that to use such a system, for the investigation of plants, is like learning to read by the Chinese character. But if we use these two methods in conjunction, they eminently assist each other. If a new plant cannot be made out but by artificial marks, its affinity may be guessed at in the natural system. We shall now proceed to give an outline of both systems, that the student may understand their principles, and comprehend their several advantages.

The Linnæan system is founded on the number, situation, and proportion of the essential organs of impregnation, termed stamens and pistils, whose uses and structure we have sufficiently explained. The classes, which are 24, principally owe their distinctions to the stamens; the orders, or subdivisions of the classes, are generally marked by the number of the pistils, or by some other circumstances equally intelligible. The names of both are of Greek derivation, and allude to the functions of the respective organs. The first eleven classes are distinguished solely by the number of the stamens.

I. *Monandria.* Stamen 1. From μονος, one, and ανηρ, a man. A small class consisting of only two orders.

1. Monogynia. Style 1. From μονη, one, and γυνη, a woman. Instances of this are, Canna, Alpinia, Lopezia, Hippuris.

2. Digynia, Styles 2. δις, two, and γυνη, Corispermum, Blitum.

II. *Diandria.* Stamens 2.

I. Monogynia, Jasminum, Salvia, Veronica.

2. Digynia. Anthoxanthum only, a kind of grass.

3. Trigynia. Piper only, or pepper.

III. *Triandria.* Stamens 3.

1. Monogynia. Valeriana, Iris, Cyperus, Scirpus.

2. Digynia. Contains almost all the natural order of true grasses.

3. Trigynia. Holosteum, Montia, Polycarpon.

IV. *Tetrandria.* Stamens 4.

1. Monogynia. Protea, Scabiosa, Plantago, Galium.

2. Digynia. Buffonia.

3. Tetragynia. Potamogeton, Ruppia.

V. *Pentandria.* Stamens 5. One of the largest classes.

1. Monogynia. Borago, Echium, Primula, and some genera removed hither from the 19th class, to be mentioned hereafter, as Viola, Jasione, &c.

2. Digynia. Chenopodium, Ulmus, Gentiana. Then follow the whole natural order of Umbelliferæ, of which Daucus, Angelica, Cicuta, and Apium, are examples.

3. Trigynia. Viburnum, Sambucus.

4. Tetragynia. Parnassia.

5. Pentagynia. Statice and Linum.

6. Polygynia. Myosurus only.

VI. *Hexandria*. Stamens 6.

1. Monogynia. Lilium, and others of its natural order, thence called Liliaceous: a tribe considered by Linnæus as the nobles of the vegetable kingdom; an idea supposed to allude not merely to their beauty and splendour, but also the text, "Consider the lilies of the field, how they grow, they toil not, neither do they spin."

2. Digynia. Oryza and Gahnia, grasses with 6 stamens.

3. Trigynia. Rumex, Colchicum, Scheuchzeria, the latter lately discovered to be a British genus, by the Rev. Mr. Dalton, of Yorkshire.

4. Tetragynia. Petiveria only.

5. Hexagynia. Wendlandia and Damasonium of Schreber.

6. Polygynia. Alisma only.

VII. *Heptandria*. Stamens 7.

1. Monogynia, Trientalis, and Æsculus.

2. Digynia. Limeum.

3. Tetragynia. Saururus.

4. Heptagynia. Septas.

VIII. *Octandria*. Stamens 8.

1. Monogynia. A large and beautiful order, containing Epilobium, Fuchsia, Vaccium, and the vast genus Erica: also, according to Dr. Smith, Acer.

2. Digynia. Mæhringia, &c.

3. Trigynia. Polygonum, &c.

4. Tetragynia. Adoxa, Paris.

IX. *Enneandria*. Stamens 9.

1. Monogynia. Laurus, famous for producing the cinnamon, sassafras, and camphor.

2. Trigynea. Rheum, the rhubarb only.

3. Hexagynia. Butomus.

X. *Decandria*. Stamens 10. A rather numerous class.

1. Monogynia. Cassia, and some other papilionaceous plants. Also Ruta and its family, followed by Kalmia, Rhododendron, Andromeda, &c.

2. Digynia. Saxifraga, Dianthus, Saponaria.

3. Trigynia. Silene and Arenária, both allied to Dianthus; also Malpighia and Bannisteria.

4. Pentagynia. Lychnis, Cerastium, and Spergula; allied also to Dianthus. Cotyledon, Sedum, and Oxalis follow.

5. Decagynia. Neurada and Phytolacca.

XI. *Dodecandria*. Stamens 12—19.

1. Monogynia. Lythrum, Halesiæ, Peganum.

2. Digynia. Agrimonia.

3. Trigynia. Reseda and Euphorbia.

4. Tetragynia. Has been recently established to receive Calligonum and Apousgeton.

5. Pentagynia. Glinus.

6. Dodecagynia. Sempervivum, the house-leek.

Thus far the Linnæan classes are founded solely upon the number of the stamens. In the following ones, insertion, proportion, and connection of the same parts are to be considered. Of all the preceding classes, the characters of the 4th, 6th, and 10th, chiefly interfere with any of the subsequent ones, as will be explained hereafter.

XII. *Icosandria*. Stamens twenty, or more, inserted into, or growing out of the calyx. This mode of insertion always indicates an eatable and wholesome fruit.

1. Monogynia. Myrtus, Amygdalus, Prunus.

2. Pentagynia. According to Dr. Smith, should comprise also the Digynia and Trigynia of Linnæus, as they all vary one into the other. Pyrus, Mespilus, Spiræa, and Mesambryanthemum.

3. Polygynia. Rosa, and its beautiful natural order, including Rubus, Fragaria, &c.

XIII. *Polyandria*. Stamens numerous, inserted into the receptacle. This class is very distinct in character and qualities from the last. Its plants are often poisonous.

1. Monogynia. A fine order. Capparis, Papaver, Nymphæa, Cistus.

2. Pentagynia. Dr. Smith recommends, in his "Introduction to Botany," the same plan in this class as in the preceding, of uniting Digynia, Trigynia, Tetragynia, and Hexagynia of Linnæus, under Pentagynia, because, as they stand now in his works, natural genera, as well as the species of one genus, are often separated, and several plants vary from one Linnæan order to another. Examples are, Pæonia, Delphinium, Aquilegia, Nigella, Stratiotes. Some Nigellæ have ten styles.

3. Polygynia. Dillenia, Magnolia, Anemone. Clematis, Ranunculus, &c.

XIV. *Didynamia*. Stamens two long and two short.

This class therefore is distinguished from the 4th by the proportion of its filaments, a circumstance which is only an index to other characters in the flower, for there is a correspondent irregularity in the form of the corolla. The class in question is almost perfectly a natural one, containing the Labiate, Ringens, or Personate flowers in general. The orders are as natural as the class, being only two, and founded on the structure of the fruit.

1. *Gymnospermia.* Seeds naked in the bottom of the calyx, almost always four. The plants are aromatic and wholesome. Some of the principal genera are, Teucrium, Mentha, Lavandula, Lamium, Thymus, and Melittis.

2. Angiospermia. Seeds inclosed in a seed-vessel, and generally very numerous. The plants of this order are handsome, but fœtid and poisonous, quite distinct in nature from those of the former, and more akin to the Pentandria Monogynia. The genera Bignonia and Antirrhinum sometimes vary, with five stamens and regular flowers. Interesting genera of this order are, Pedicularis, Chelone, Antirrhinum, Linnæa, Orobanche, and Acanthus.

XV. *Tetradynamia.* Stamens four long and two short. A natural class, comprising the cruciform flowers, except Cleome, which is thought to have been erroneously placed here. The orders are two, perfectly natural.

1. Siliculosa. Fruit a roundish pod or pouch, Myagrum, Draba, Lunaria, Alysum, Cochlearia, Thlaspi.

2. Siliquosa. Fruit a very long pod, Dentaria, Cardamine, Cheiranthus, Brassica, Sinapis.

XVI. *Monadelphia.* Stamens united by their filaments into one tube. This the first class in which the connection of those parts is taken into consideration. Number therefore being here of secondary importance, serves to discriminate the orders.

1. Triandria. Sisyrinchium, Ferraria, Tamarindus, Aphyteia.

2. Pentandria. Erodium, Hermannia.

3. Heptandria. Pelargonium only, separated from Geranium by L'Herritier, an eminent French botanist.

4. Octandria. Aitonia, named by the younger Linnæus after the late Mr. Aiton of Kew garden.

5. Decandria. Geranium.

6. Endecandria. Brownea only.

7. Dodecandria. Stamens generally fifteen. Pterospermum, Pentapetes, &c.

8. Polyandria. The finest order of the whole, contains Malva, Sida, Althæa, Lavatera, Gossypium, Hibiscus, Camellia, and others; most mucilaginous emollient plants.

XVII. *Diadelphia.* Stamens united by their filaments into two parcels, both sometimes cohering at the base. Flowers almost universally papilionaceous.

1. Pentandria. Monnieria only.

2. Hexandria. Saraca, Fumaria.

3. Octandria. Polygala.

4. Decandria. The largest and most natural order, the sections of which require to be studied with care.

* Stamens all united. These plants are strictly monadelphous, and it is only on account of their close affinity to the rest of the order, that Linnæus took the liberty of placing them here. Some of them, indeed, as Lupinus and Ulex, have the tenth stamen unlike the rest, though united with them below. No confusion arises in practice from this seeming contradiction of the character of the class, because the habit of these flowers is so clear and distinct from all others. If, however, a papilionaceous plant has its ten stamens all separate and unconnected, it is necessarily to be referred to the tenth class.

** Stigma downy. Without the character of the foregoing section. Phaseolus, Dolichos, Orobus, Pisum, Lathyrus, Vicia, to which Dr. Smith has added Eroum, after separating from the latter some species erroneously referred to it. See Flora Britannica, 776.

*** Legume imperfectly divided into two cells. Always without the character of the preceding sections. Biserrula, Phaca, Astragalus, the last a very extensive and intricate genus.

**** Legume with scarcely more than one seed. Psoralia, Trifolium, the latter a very irregular genus in character, though distinct in habit, sufficiently known for its agricultural uses.

***** Legume composed of single valved joints, which are rarely solitary. Hedysarum, Hippocrepis, Coronilla, Smithia, the latter furnished with irritable leaves like the true Sensitive plant or Mimosa.

****** Legume of one cell with several seeds. Many species of Trifolium properly belong here, and have been separated by some authors under the name of Melilotus: also the valuable Indigofera, with Cytisus, Robinia, Lotus, and Medicago.

XVIII. *Polyadelphia.* Stamens united by their filaments into more than two parcels. Orders characterised by the number or insertion of their stamens. In this class Dr. Smith has made many corrections, and the orders in his Introduction to Botany stand as follows.

1. Dodecandria. Stamens, or rather anthers, from twelve to twenty or twenty-five. Their filaments unconnected with the calyx. Theobroma, the chocolate tree, Bubroma, Abroma, Monsonia, and Citrus.

2. Icosandria. Stamens numerous, their filaments inserted into the calyx, in several parcels of course, as Melaleuca, a fine aromatic genus, principally from New Holland.

3. Polyandria. Stamens very numerous, unconnected with the calyx. Hypericum is the principal genus here.

XIX. *Syngenesia.* Anthers united into a tube. Flowers compound. This is entirely a natural class, and its orders likewise are founded on natural characters.

1. Polygamia Æqualis. Every one of the florets which constitute the compound flowers is, in this order, perfect within itself, having perfect stamens, and pistil with one seed. The florets are either ligulate, as in the dandelion; tubular, forming a globose head, as in the thistle; or tubular, and level at the top; or discoid, as in lavender cotton, *santolina*.

2. Polygamia Superflua. Florets of the disk like the discoid, flowers of the last order, and, like them, perfect within themselves. Those of the margin furnished with pistils only, but all the florets produce perfect seed. In this order the marginal florets are sometimes minute and inconspicuous, but they are for the most part ligulate, and form diverging rays, as in the daisy, aster, chrysanthemum, &c.

3. Polygamia Frustranea. Differs from the last order only in having the florets of the margin abortive or neuter; in the former case there are no rudiments of a pistil in these florets, as in centaurea; or there are abortive pistils, as in the sunflower. This order is considered by Dr. Smith as not essentially different from the last.

4. Polygamia necessaria. Florets of the disk furnished with perfect stamens only, those of the margin with perfect pistils only, as in the garden marigold, *calendula*.

5. Polygamia Segregata. Several flowers, either simple or compound, with united anthers, and a partial calyx, all included in one general calyx, as the globe thistle, &c.

Another order follows in Linnæus, called Monogamia, consisting of simple flowers with united anthers; but this order is now generally abolished. The circumstance of the union of the anthers in simple flowers being extremely various and uncertain, though in compound ones scarcely liable to any exception.

XX. *Gynandria.* Stamens inserted either upon the style or germen. Such is the true idea of this class, and its character, thus understood, is as much founded in nature and reality as that of any other; by which we do not mean, that the class is a natural one, like the 19th, as it, in fact, comprises several natural families, whose allies may happen to be in other classes. Linnæus, in his idea of this class, has understood, as belonging to it, many plants, whose stamens did not really grow out of the germen, as the passion-flower, the sisyrinchium, &c. Hence Thunberg, and some other botanists, have judged the class altogether untenable. In the orders, some alterations have recently been made by Dr. Smith, the reasons for which are more fully particularized in his Introduction to Botany, than we have room here to explain. These orders are distinguished by the number of stamens. Monandria, the first of them, contains almost all the Orchis tribe. To the fifth, Pentandria, Dr. Smith refers many of the natural family of Contortæ, as Pergularia, Cynanchum, and Asclepias, a curious tribe, the structure of whose organs of impregnation is extremely puzzling even to the botanical adept. They have hitherto been placed in the fifth class, and some have thought they should be referred to the tenth. In the sixth order of this class, Hexandria, we find the aristolochia, or birth-wort.

XXI. *Monoecia.* Stamens and pistils in separate flowers, but on the same plant.

The orders of this class are, like those of the last, distinguished by the number of the stamens, or by some other character of the foregoing classes. The most genuine examples of it are such as have a different structure in the two kinds of flowers, besides the essential difference with respect to stamens and pistils, as the oak, chesnut, hazle.

XXII. *Dioecia.* Stamens and pistils like the former in separate flowers, but on two separate plants.

The orders of this class are characterised like those of the preceding. The willow, hop, hemp, &c. belong to it.

XXIII. *Polygamia.* Stamens and pistils separate in some flowers, united in others, either on one, two, or three distinct plants. Dr. Smith has first suggested that no plants should be admitted into this class, without a difference in the accessory parts of their flowers, over and above what concerns the stamens and the pistils. Without such a rule, the class would be overwhelmed with the trees of tropical countries.

The orders are, Monoecia, when the several kinds of flowers grow on one plant, as Atriplex: Dioecia, when they are situated on two separate ones; and Trioecia, when they occupy three several individuals of the same species.

XXIV. *Cryptogamia*. Stamens and pistils either not well ascertained, or not to be numbered with certainty.

1. *Filicia*, ferns, whose flowers are almost entirely unknown. The seed-vessels commonly grow on the back of the leaf, thence denominated a frond, and are either naked, or covered with a membrane. In some few they form spikes or clusters of capsules.

2. *Musci*, mosses, a peculiar family of plants, possessing great elegance, though diminutive in size; extremely tenaceous of life, growing in the hottest as well as the coldest climates; flourishing most in the damp wintry months. Their herbage consists of pellucid leaves, sometimes accompanied with a stem; their capsule is of one cell and of one valve, closed with a vertical lid; seeds numerous and small; the capsule is covered with a calyptra or membranous veil, the summit of which is the stigma, a circumstance absolutely peculiar to this family; the stamens are mostly in a separate flower, and numerous. The late Dr. Hedwig of Leipsic is celebrated for his discoveries relating to mosses. He has distinguished their genera by the peristomium or fringe, which in most cases surrounds the mouth of the capsule. This fringe is either single or double. In the former case it consists of either four, eight, sixteen, thirty-two, or sixty-four teeth. The inner peristomium when present is more membraneous, plaited, and jagged. The principles of Hedwig have been adopted, with a few requisite limitations, by the most able writers in this branch of botany.

3. *Hepaticæ*, liverworts. The herbage of these plants is most generally a frond, or leaf, bearing the fructification; but they differ most essentially from the last order in the want of a lid to the capsule, which is formed quite on a different principle from that of mosses, and very various in the several genera. Jungermannia and Marchantia are examples of this order.

4. *Algæ*, flags. The herbage of these is also frondose, being sometimes a powdery crust, sometimes leathery or gelatinous; the seeds are embedded in the frond, or in some appropriate receptacle; the stamens are scarcely known. The vast family of Lichen occurs here, the most hardy of vegetables, clothing exposed rocks, trunks of trees, and barren heaths, in the most cold and inhospitable climates. On one of them the rein-deer depends for sustenance in the winter. Others are useful in dyeing, and even medicine. The numerous and various tribe of sea-weeds, Fucus, Conferva, and Ulva, are classed here.

5. *Fungi*, mushrooms. These are fleshy in substance, of quick growth, and generally of short duration. They are divided into Angiocarpi, which bear seeds internally; and Gymnocarpi, whose seeds are imbedded in an exposed membranous organ. Many of these are eatable, some poisonous. Linnæus had a great prejudice against the use of any of them as food.

APPENDIX. *Palmæ*. The magnificent natural order of palms was placed by Linnæus as an appendix to his system, because their parts of fructification were not well known when he first wrote. They are now, however, in general so well understood, that the plants in question are easily reducible to the regular classes of the Linnæan system; and it would be advisable for any future editor to arrange them accordingly. They principally belong to the Hexandria Monogynia, and are nearly allied to many plants already referred to that class.

Palms are called by Linnæus the princes of the vegetable kingdom, and are remarkable for their lofty growth, their simple stems crowned with evergreen leaves, and their abundant fruits. Among them we find the date, so valuable an article of food for many nations; the cocoa-nut, and many other fruits of less value. Some supply whole nations with oil, for food or economical uses, from their fruits; with wine from the juices of their stem, or with cordage from its fibres.

We shall now proceed to give a sketch of the natural system of arrangement published by Jussieu, a botanist of the first eminence, now living at Paris. Its primary divisions are founded upon the structure of the seed, whence is derived the distinction of all plants into Acotyledones, destitute of a cotyledon; Monocotyledones, such as have one cotyledon; and Dicotyledones, such as have two. Under the last are included a few genera that have numerous cotyledons, as Pinus and its allies, which Jussieu considers as having two cotyledons, each divided into several segments, but erroneously. So that this last section should rather be characterized as having two or more cotyledons.

The classes of Jussieu's method are fifteen, and comprize in all an hundred orders. These classes have no appropriate names, but are distinguished by numbers, with a short definition of the essential character. The orders, except those of the first class, are for the most part named after some principal genus belonging to each. It is to be observed, that, with respect to the cotyledons, there are some inaccuracies in the terms used, for many of the supposed Monocotyledones are now known to have no cotyledon at all, and what has been so called in the rest is more properly an albumen.

Class I. *Acotyledones.* The orders of this are in a great measure analogous to the 24th class in Linnæus. 1. *Fungi*; 2. *Algæ*; 3. *Hepaticæ*; 4. *Musci*; 5. *Filicis*; to which is added a sixth, termed *Naiades*, which contains several water plants, as Hippuris, Myriophyllum, Potamogeton, Lemma, &c. Along with which Jussieu reckons several genera, of the structure of whose seed, and consequently of the primary character of whose class, he was uncertain.

Class II. *Monocotyledones* with the stamens inserted beneath the germen, or, in Linnæan language, having the germen superior.

The orders are four, 7. *Aroideæ*; as Arum, &c. 8. *Typhæ*, consisting of Typha and Sparganium; 9. *Cyperoideæ*, as Carex, Scirpus, Cyperus, &c. and, 10. *Gramineæ*, the true grasses.

Class III. *Monocotyledones*, with the stamens inserted round the pistil, this is upon the calyx or corolla.

The orders are eight, 11. *Palmæ*, of which we have spoken at the end of the Linnæan system; 12. *Asparagi*, Asparagus, Convallaria, &c.; 13. *Junci*, Juncus, &c. to which are added, Commelina, Butomus, Sagittaria, Veratrum, and even Colchicum. 14. *Liliæ*, as Tulipa, Fritillaria, Lilium, &c. 15. *Bromeliæ*, of which the Pine apple and Agave are instances; 16. *Asphodeli*, consisting of Aloe, Asphodelus, Hyacinthus, Ornithogalum, Allium, and several others. 17. *Narcissi*, Hemerocallis, Amarylis, Narcissus, Galanthus, and others; 18. *Irides*, Ferraria, Iris, Ixia, Gladiolus, Crocus, exemplify this order.

Class IV. *Monocotyledones*, with the stamens inserted upon the germen or style, that is, having the germen inferior.

The orders are four, 19. *Musæ*, including the Plantain-tree and Heliconia; 20. *Cannæ*, which are the Scitamineæ of Linnæus and other writers, and which have been lately so ably illustrated by Mr. Roscoe, in the 8th volume of the Linnæan Society's Transactions; 21. *Orchideæ*, a beautiful and favourite tribe; 22. *Hydrocharideæ*, a rather obscure order, under which Jussieu enumerates Vallisneria, Stratiotes, Hydrocharis, and some others which are very doubtful, or rather certainly misplaced here.

Class V. *Dicotyledones*, without petals, stamens as in the last class.

Order only one, 23. *Aristolochiæ*, consisting of Aristolochia, Asarum, and Cytinus, in the first of which Jussieu takes for a calyx what other botanists esteem a corolla.

Class VI. *Dicotyledones*, without petals, stamens inserted into the calyx.

The orders are six; 24. Elæagni, as Hippophae, Elæagnus, Thesium, &c.; 25. *Thymeleæ*, which comprises Daphne, Passerina, and their allies; 26 *Proteæ*, consisting of the great Cape family Protea, Banksia, Embothrium, &c.; 27. *Lauri*, as Laurus, and some other genera, supposed to be allied to it; 28. *Polygoneæ*, composed of Polygonum, Rumex, Rheum, &c.; 29 *Atriplices*, Chenopodium, Atriplex, and others.

Class VII. *Dicotyledones*, without petals, stamens inferior to the germen.

The orders are four, 30. *Amaranthi*, Amaranthus, Celosia, Gomphrena, Herniaria, &c.; 31. *Plantagines*, Psilium, Plantago, and Littorella; 32. *Nyctagines*, Mirabilis, Boerhaavia, &c.; 33. *Plumbagines*, Plumbago, and Statice.

Class VIII. *Dicotyledones*, of one petal, which is inserted under the germen.

The orders are fifteen, 34. *Lysimachiæ*, Anagallis, Primula, &c. with some doubtful ones; 35. *Pediculares*, Veronica, Euphrasia, Pedicularis, &c.; 36. *Acanthi*, Acanthus, Ruellia, Justicia; 37. *Jasmineæ*, Syringa, Fraxinus, olea, Jasminum; 38. *Vitices*, a numerous order, Clerodendrum, Volkameria, Vitex, Verbena, &c.; 39. *Labiatæ*, a large order, containing the Didynamia Gymnospermia of Linnæus, with some few from his Diandria, as Salvia, &c.; 40. *Scrophulariæ*, consists chiefly of the Didynamia Angiospermia of Linnæus; 41. *Solaneæ*, Verbascum, Hyocsyamus, Atropa, Solanum, with some other plants of the Linnæan 5th class, and a few of the Didynamia compose this order; 42. *Borragineæ*, contains the Asperifoliæ, as Borago, Anchuso, Echium, &c. with Cordia, Varronia, Hydrophyllum, and some others; 43. *Convolvuli*, Convolvulus, Ipomæa, Evolvulus, and some doubtful genera; 44. *Polemonia*, Phlox, Polemonium, &c. with Ipomopsis of Michaux and Smith; 45. *Bignoniæ*, Chelone, Bignonia, Martynia, and a few others; 46. *Gentianæ*, consists of some remarkably bitter plants, Gentiana, Swertia, Chlora, Lisianthus, Chironia; 47. *Apocinæ*, the Contortæ of Linnæus, some of which belong to his Pentandria, as Vinca, Nerium, Apocynum, &c. and others have been referred by Dr. Smith to Gynandria, as Pergularia, Cynanchum, and Asclepias; 48. *Sapotæ*, Achras, Chrysophyllum, Jacquinia, and others.

Class IX. *Dicotyledones*, of one petal, inserted into the calyx.

Orders four, 49. *Guaïacanæ*, consisting of Diospyros, Styrax, Halesia, Symplocos, &c.; 50. *Rhododendra*, as Kalmia, Rhododendrum, Azalea; also Rhodora, Ledum, Bejaria, and Itea, which four last but ill accord with the character of the class, being really polypetalous; 51. *Ericæ*, as the vast genus Erica, also Andromeda, Arbutus, Pyrola, Clethra, Vaccinium, and others, several of which are likewise polypetalous; 52. *Campanulaceæ*, some of these have distinct anthers, as Campanula, Trachelium, Roella, Scœvola, Phyteuma; others have the same parts cohering, as Lobelia and Jasione. To this order belong Dr. Smith's Goodenia and Stylidium; see his introduction to Botany, 464.

Class X. *Dicotyledones*, of one petal, crowning the germen. Anthers united into a tube. Flowers compound. Orders three.

This class comprises the Syngenesia of Linnæus, except his last order Monogynia, which, as we have already mentioned, is now laid aside. 53. *Cichoraceæ*, consists of such of Linnæus's order of Polygamia Æqualis as have ligulate florets, as Sonchus, Hieracium, Leontodon, Tragopogon, Catananche, &c.; 54. *Cinarocephalæ*, the Thistle tribe, Carthamus, Carlina, Cinara, Carduus, Centaurea, of which last Jussieu makes several genera; 55. *Corymbiferæ*, is a large order, containing the rest of the Linnæan Syngenesia, most of which are radiated flowers, except the first section. Examples of this order are, Eupatorium, Gnaphalium, Conyza, Senecio, Calendula, Chrysanthemum, Artemisia, Anthenis, Bidens, Helianthus, Arctotis, besides some very anomalous ones with separated flowers, whose anthers are scarcely connected, as Ambrosia, Xanthium, &c.

Class XI. *Dicotyledones*, of one petal, crowning the germen. Anthers distinct.

Orders three, 56. *Dipsaceæ*, the flowers of which are generally aggregate, as Dipsacus, and Scabiosa; Valeriana has simple flowers; 57. *Rubiaceæ*, a vast order, is exemplified by Galium, Rubia, Hedyotis, Cinchona, Gardenia, Ixora, Coffea; 58. *Caprifolia*, as Linnæa, Lonicera, Sambucus, Cornus, Hedera.

Class XII. *Dicotyledones*, with several petals, stamens inserted upon the germen.

Orders two, 59. *Araliæ*, a small order, the fruit pulpy or capsular, contains chiefly Aralia, Cussonia, and Panex; 60. *Umbelliferæ*, a very large and natural order, sufficiently well known to those who have at all considered plants, though not a favourite tribe with botanists in general. Some of the chief genera are, Thapsia, Scandix, Angelica, Heracleum, Athamanta, Daucus, Caucalis, Bupleurum, and Chœrophyllum.

Class XIII. *Dicotyledones*, with several petals, stamens inserted under the germen.

Orders twenty-two, 61. *Ranunculaceæ*, the acrid tribe of Clematis, Thalictrum, Anemone, Ranunculus, Helleborus Aconitum, Pœonia, Actæa, and Cimifuga; 62. *Papaveraceæ*, consists of Papaver Chelidonium, and their allies; 63. *Cruciferæ*, the great natural order of cruciform plants, constituting the Linnæan Tetradynamia, as Brassica, Cheiranthus, Alyssum, Thlaspi; 64. *Capparides*, Cleome, Capparis, &c. to which are subjoined, as akin to them, Reseda, Drosera, Parnassia; 65. *Sapindi*, Sapindus, Paullinia; 66. *Acera*, Æsculus, Acer, &c.; 67. *Malpighiæ*, Bannisteria, Malpighia, and a few others. These three last orders are somewhat obscurely defined; 68. *Hyperica*, consists of Ascyrum Brathys, and Hypericum; 69. *Guttiferæ*, an original order of Jussieu's, and a very natural one, contains Gambogia, Clusia, Garcinia, Mammea, Calophyllum, and some others; 70. *Aurantia*, Citrus, Limonia, Murræa, genera remarkable, for the pellucid spots in their leaves probably exemplify this order, to which are added among others Thea and Camellia; 71. *Meliæ*, a very natural order, of which the tubular nectarium bearing the stamens, is the principal character, as Turræa Aitonia, Trichilia, Melia, Swietenia, and Cedrela, the two last are kinds of mahogany; 72. *Vites*, consists only of Cissus and Vitis; 73. *Gerania*, consists of Geranium (including Pelargonium and Erodium of L'Heritier) and Monsonia, to which are subjoined, as akin to them, Tropœolum, Impatiens, and Oxalis; 74. *Malvaceæ*, Malva, Lavatera, Hibiscus, and others, constituting the Monodelphia class of Linnæus, with some others related thereto; 75. *Magnoliæ*, composed of Magnolia, Liriodendron, Micheliæ, with some others; 76. *Anonæ*, nearly allied to the last, as Anona, Unona, Uvaria, and Hilopia; 77. *Menisperma*, Cissampelos, Menispermum, &c.; 78. *Barberides*, Berberis, Leontice, Epimedium, with some supposed to be allied to them; 79. *Tiliaceæ*, Hermannia, Sparmannia, Grewia, Tilia, &c.; 80. *Cisti*, Cistus is the chief and most certain of these, from which genus Jussieu separates Helianthemum; 81. *Rutaceæ*, Tribulus, Zygophyllum, Ruta Dictamnus, and others; many new genera of this order have been discovered in New Holland: see Tracts relating to Natural History, by Dr. Smith, who considers Oxalis as belonging here; 82. *Caryophyleæ*, the Pink and Campion tribe, which is very natural, as Spergula, Arenaria, Dianthus, Silene, &c.

Class XIV. *Dicotyledones*, with several petals, stamens inserted into the calyx or corolla.

Orders thirteen, 83, *Sempervivæ*, a succulent tribe, Cotyledon, Sedum, Sempervivum; 84. *Saxifragæ*, Saxifraga, Chrysosplenium, &c. among which Hydrangea must surely rather belong to the *Caprifolia*; 85. *Cacti*, consists of Ribes and Cactes, a paradoxical association; 86. *Portulaceæ*, Portulaca, Tamarix, Claytonia, &c. the last mentioned genus is suspected to be monocotyledonous; 87. *Ficoideæ*, of which the most remarkable is the vast genus Mesembryanthemum; 88. *Onagræ*, Œnothera, Epilobium, and Jussiæa, exemplify this, and the beautiful Fuchsia, with others, are subjoined, some of which belong to the following order; 89. *Myrti*, a fine and very natural family, composed of Melaleuca, Septospermum, Eucalyptus, Myrtus, Eugenia, &c.; 90. *Melastomæ*, as Melastoma, Osbeckia, Rhexia, all remarkable for handsome anthers; 91. *Salicariæ*, Lythrum, Lawsonia, Peplis, Glaux, &c.; 92. *Rosaceæ*, a very large and fine order, constituting in general the Icosandria of Linnæus: as Pyrus, Rosa, Fragaria, Rubus, Prunus, with many more; 93. *Leguminosæ*, a still more extensive order than the preceding, in which the system under our consideration, as keeping so natural an order entire, has much the advantage of the Linnæan artificial system, which, being founded only on the stamens, unavoidably disunites it. To this are referred, Mimosa, Tamarindus, Cassia, Poinciana, Bauhinia, Sophora, Genista, Lupinus, Trifolium, Phaseolus, Astragalus, Vicia, Hedysarum, Pterocarpus, and many other genera related to each of the above; 94. *Terebintaceæ*, a rather confused order; in it we find Rhus, Canarium, Schinus, Pistacia, Zanthoxylum; and even Juglans, is put here on account of a slight affinity; 95. *Rhamni*, is a more satisfactory order; as Euonymus, Celastrus, Cassine, Ilex, Rhamnus, &c.

Class XV. *Dicotyledones*, with stamens, in separate flowers, from the pistils.

Orders five. 96. *Euphorbiæ*, consists of Mercurialis, Euphorbia, Phyllanthus, Buxus, Croton, Hippomane, with several more, for the most part acrid, and often milky plants; 97. *Cucurbitaceæ*, the gourd tribe, Bryonia, Cucumis, Passiflora, with a few more; 98. *Urticæ*, composed of Ficus, Morus, Urtica, Humulus, Cannabis, to which, among others, Piper is subjoined, as an ally; 99. *Amentaceæ*, Salix, Populus, Betula, Quercus, Corylus, &c. to which Ulmus, Celtis, and Fothergilla, are prefixed; 100. *Coniferæ*, Casuarina, Juniperus, Cupressus, are examples of this very distinct order.

At the end of this system is a large assemblage of genera, under the denomination of *Plantæ incertæ sedis*, as not capable of being referred to any of the foregoing orders. Some of them, perhaps, when better known, may be removed into the body of the system, but many must always remain in doubt. Nor is this to be esteemed as a fault peculiar to the system of Jussieu. It must be the case with all natural systems, unless it were possible for their contrivers to have all the genera of plants from every corner of the earth before them at one view.

As long as any remain to be discovered, or any that are discovered are imperfectly known, every such system must be defective. Besides, it appears that plants are connected, not in one regular series, but, as it were, in a circle, touching or approaching each other by so many different points, that no human sagacity can detect which points of connection are most important, so as to obtain an infallible clue through so vast a labyrinth.

A natural system of botanical arrangement being therefore probably unattainable in perfection, we are obliged to be content, for daily use, with an artificial one. When we meet with an unknown plant, we count its stamens and styles, or observe any other circumstances attending those organs, on which the characters of the Linnæan classes are founded. Having easily determined the class of our plant, we in like manner ascertain its order. We proceed to compare the parts of its flower and fruit with the characters of every genus in that order, till we find one that agrees with them. Having fixed the genus, we in like manner read over the characters of the species, in case the genus consists of more than one, till we are satisfied we have met with the right. Thus we learn the generic and specific name of our plant, and are enabled to find any thing recorded concerning it.

Such is the mode of applying the Linnæan system to use, and in ordinary cases no difficulties attend it. But it may happen, that we have found a plant whose number of stamens is variable in itself, or perhaps different from their usual number in the natural genus to which it belongs; for all genera ought to be natural, and no species must be divided from its brethren, on account of characters which only respect the artificial classes and orders. In this case Linnæus has provided us a remedy, by enumerating at the head of each class all such anomalous species, as far as he could recollect or determine them; so that if our plant does not agree with any of the regular genera of the class, we may seek it among these irregular species. If, after all our attempts, the plant under consideration still proves refractory, the system of Jussieu comes to our aid. Not that we can hope, even though adepts in the science, to determine a plant by the same mode in this author; beginning with the cotyledons, which, in many cases, we shall find it impossible to judge of, and which, when found, will often lead us astray in the more abstruse orders of Jussieu.

The true way to use this system is, to consider what known genus or family our plant most approaches in its habit and leading characters. By turning to such, through the help of the index, and reading the characters of the corresponding order, we shall be able to judge how far we are right, and shall, at any rate, grow familiar with natural orders and affinities. When we have determined the genus of our plant in Jussieu, as he has not treated of species, we must still recur to Linnæus for that part of the subject, as well as for synonyms of other authors, and references to figures or descriptions.

By such a manner of associating these two great authors, we render them truly serviceable to each other, and to the science; whereas, by placing them in opposition, we only make stumbling-blocks of all their defects; for there must be defects in all attempts of the human intellect to keep pace with the infinite wisdom and variety displayed in the works of God.

With respect to the application of either of these methods of arrangement to medical use, as a means of forming any probable judgment of the qualities of plants, the more natural any system is, the better it serves us in this particular. But even the Linnæn classes and orders are many of them sufficient for general use, and their learned author has occasionally suggested other remarks, peculiar to himself, tending to the same end.

His Didynamia Gymnospermia, and the ringent flowers with naked seeds, allied thereto, which, having only two stamens, are necessarily placed in his second class, Diandria, are all innocent or wholesome: those of the other order, Angiospermia, are fetid, narcotic, and dangerous, being akin to a large part of Pentandria Monogynia, known to be poisonous, as containing henbane, nightshade, and tobacco. The whole class Tetradynamia is wholesome, except the fetid cleome, wrongly referred to it. Whenever the stamens are found to grow out of the calyx, whether they be numerous, as in Icosandria, or few, as in the currant and gooseberry, they infallibly indicate the pulpy fruits of such plants to be wholesome. Whenever the nectary is a distinct organ or structure from the petals, Linnæus justly observes, that the plants to which it belongs are to be suspected. The papilionaceous or pea flower is remarked by him to belong to a wholesome family, which is generally true, at least when the plants are boiled or roasted. We think it right, however, to mention one exception to the innocence of this family, as it is not generally known. The seeds of the laburnum, eaten unripe, are violently emetic and dangerous. They are, indeed, so bitter and nauseous as seldom to tempt children, but we have heard of their being eaten, and such was the consequence, which is the more important to be known, as the tree is so common.

Milky plants are generally to be suspected, except such as have compound flowers; but even some of these are highly dangerous, as the wild lettuce, Lactuca virosa, which yields a kind of opium, and the stinking hawkweed, crepis fœtida. Crepis rubra, also, or pink hawkweed, commonly cultivated for its beauty, may be in the same predicament; but it is too nauseous to be eaten. Umbelliferous plants, which grow in dry or elevated situations, are aromatic, safe, and often very wholesome; while those that inhabit low and watery places are usually among the most virulent and deadly of all poisons whatever. Oenanthe crocata poisons by its scent in a room, causing headaches, nausea, and swoonings. Cicuta virosa, if eaten by cattle unawares, while under water, kills them, as Linnæus informs us, with the most horrible symptoms. The mallow tribe, or Columniferæ, so called from bearing their stamens in a columnar form, are all emollient, abounding with a mucilaginous juice, without taste and smell, very useful in internal irritations. To this, probably, Horace alludes, when he speaks of læves malvæ, and not to any external smoothness of the plants mentioned, which, by their soft and downy leaves, would rather claim the epithet of molles. The liliaceous family are often very dangerous, especially their bulbous roots, from some of which the wild natives of southern Africa are said to obtain a poison for their darts. The natural order of grasses are, as every one knows, wholesome throughout; for the intoxicating effects recorded of Lolium temulentum can hardly be deemed an exception. The beneficent Author of Nature has usually indicated the wholesome qualities of plants by an agreeable smell or taste, while dangerous ones are endued with contrary flavours. The berries of deadly nightshade, *Atropa belladonna*, are indeed an exception to this, but a rare one.

When we speak here of plants as being wholesome or poisonous, it must be understood only with a reference to our own species, and those animals which most approach us in shape and constitution, as quadrupeds, and even of these some form an exception. Thus goats prefer and thrive upon the most acrid plants, which blister the stomachs, or even hands, of the human species, as clematis, anemone, ranunculus, &c. Insects, in general, feed on the most virulent herbs, which no other animals can taste, and thus such are turned to account in the general plan of nature. The art of cookery renders many vegetables wholesome to man, that without it would be far otherwise, as the potatoe, which is a species of nightshade, or Solanum, and many fruits are rendered much more salutary in consequence of being dressed. The cassava bread of the West Indies is made of the highly acrid Jatropha, purified by washing and drying. A number of further observations might be added; but the above are sufficient to shew the use of botanical science in a medical point of view. The necessity that those who make use of highly powerful plants for the cure of diseases should know one plant from another is evident. We have known the useless Lythrum salicaria gathered, and sold to the apothecary, for fox-glove, and the sweet, inactive chervil for the powerful hemlock; we have also known henbane taken for clary. A little science will guard against such mistakes. The "Medical Botany" of the late Dr. Woodville, so extensive in its sale among country practitioners, has perhaps done more to prevent them than most other books; but the liberal and dignified physician should be able, by more philosophical means, not only to guard against mistakes and mischief, but, by new inquiries and studies, to advance the healing art.

BOTE, in our old law-books, signifies recompence or amends: thus manbote, is a compensation for a man slain.

There are likewise house-bote and plough-bote, privileges to tenants of cutting wood for making ploughs, repairing tenements, and likewise for fuel.

BOTRYCHIUM, in botany, a genus of the Cryptogamia Filices class and order: capsule nearly globular, distinct, clustered in a raceme-like spike; one-celled, opening from the top to the base. There are five species.

BOTTLE, a small vessel proper for holding liquors. We say a glass bottle, a stone bottle, a leathern bottle, a wooden bottle, a sucking bottle. Of glass bottles no mention occurs before the 15th century: for the "Amphoræ vitreæ" of Petronius, to the necks of which were affixed labels, expressing the name and age of the wine, appear to have been large jars, and to have formed part of the many uncommon articles, by which the voluptuary Trimalchio wished to distinguish himself. It is, however, singular, that these convenient vessels were not thought of at an earlier period, especially as among the small funeral urns of the ancients many are to be found, which, in shape, resemble our bottles.

Beckman conceives that he discovers the origin of our bottles in the figure of the Syracusan wine-flasks. Charpentier cites, from a writing of the year 1387, an expression, which seems to allude to one of our glass bottles; but this, attentively considered, refers merely to cups, or drinking glasses. The name boutiaux, or boutilles, occurs in the French language for the first time in the 15th century; but if it were more ancient, it would prove nothing, as it signified originally, and still signifies vessels of clay or metal, and particularly of leather. Such vessels filled with wine, which travellers were accustomed to suspend from their saddles, might be stopped with a piece of wood, or closed my means of wooden or metal tops screwed on them; and such are still used for earthen pitchers. We shall here add, that stoppers of cork must have been introduced after the invention of glass bottles. In 1553, they were little known; and their introduction into the shops of the apothecaries in Germany took place about the end of the 17th century. Before that period, they used stoppers of wax, which were more troublesome and more expensive. The ancient Jewish bottles were kegs made of goats' or other wild beasts' skins, with the hair on the inside, well sewed and pitched together; an aperture in one of the animal's paws serving for the mouth of the vessel. Calmet.

Bottles of this kind are mentioned in scripture, and they were used for carrying water through the deserts of Arabia and other countries, where springs and streams are scarce. Such bottles, indeed, have been in common use both in ancient and modern times. The word used by Job (ch. xxxii. 19.) signifies, in the original, to swell or distend; it is properly used to express a skin bottle, which would be made to swell by the liquor poured into it, and which would be more distended and enlarged, till they would at last burst, if they had no vent by the fermentation of the liquor as it advanced towards ripeness. Hence we perceive the propriety of putting new wine into new bottles, &c. according to the appropriate allusion in the gospels, which, being moist and strong, would resist the expansion, and preserve the wine to due maturity; whereas old bottles of this kind, being dry and more brittle, would be in danger of bursting, and were best adapted to receive old wine, the fermentation of which had ceased.

These leather bottles are supposed, by a sacred historian, not only to be frequently rent, when grown old and much used, but also to be capable of being repaired (Josh. ix. 4.) Modern travellers, as well as ancient authors, frequently take notice of these leathern bottles. The Arabs, says Sir John Chardin, and all those who lead a wandering life, keep their water, milk, and other liquors, in these bottles, the manner of repairing which he also describes. They serve, according to this writer, to preserve their contents more fresh than in any other way. They are made, he says, of goat-skins: when the animal is killed, they cut off its feet and its head, and in this manner they draw it out of the skin without opening the belly. They afterwards sew up the places where the legs were cut off, and the tail, and when it is filled, they tie it about the neck. These nations, and the country people of Persia, never go a journey without a small leathern bottle of water hanging by their side like a scrip. The great leathern bottles are made of the skin of an he-goat, and the small ones, that serve instead of a bottle of water on the road, are made of a kid's skin. In speaking of the Persians, the same traveller says, that they use leathern bottles, and find them useful in keeping water fresh, especially if people, when they travel, take care to moisten them, wherever they find water. The evaporation thus furnished, serves also to keep the water cool. He says that the disagreeable taste of the leather is taken off, by causing it to imbibe rose water when it is new, and before it be applied to use.

Formerly, it is said, the Persians perfumed these leathern vessels with mastic, or with incense. From him also we learn, that they put into these goat-skin and kid-skin vessels every thing which they want to carry to a distance in the East, whether dry or liquid; they are thus preserved fresher than if they were conveyed in boxes or pots: the ants and other insects are prevented from getting among them, and they are thus kept free from dust; and for these reasons butter, honey, cheese, and other such aliments, are inclosed in vessels made of the skins of these animals. Accordingly the things, particularly the balm and honey, which were somewhat liquid, that were carried to Joseph as a present, were probably inclosed in little vessels made of kid-skins. Homer also refers to this mode of preserving various kinds of provision in leathern vessels. Glass bottles are better for cider than those of stone. Foul glass bottles are cured by rolling sand or small shot in them; musty bottles by boiling them. Bottles are chiefly made of thick coarse glass; though there are likewise bottles of boiled leather made and sold by the case-makers. Fine glass bottles, covered with straw or wicket, are called flasks. The quality of the glass has been sometimes found to affect the liquor in the bottle.

BOTTOM, in navigation, is used to denote as well the channel of rivers and harbours, as the body or hull of a ship: thus, in the former sense, we say, a gravelly bottom, clayey-bottom, sandy-bottom, &c. and in the latter sense, a British bottom, a Dutch bottom, &c.

By statute, certain commodities imported in foreign bottoms, pay a duty called petty customs, over and above what they are liable to, if imported in British bottoms.

BOTTOMRY, in commerce, a marine contract for the borrowing of money upon the keel or bottom of a ship; that is to say, when the master of a ship binds the ship itself, that if the money be not paid by the time appointed, the creditor shall have the said ship.

Bottomry is also where a person lends money to a merchant, who wants it in traffic, and the lender is to be paid a greater sum at the return of the ship, standing to the hazard of the voyage. On which account, though the interest be greater than what the law commonly allows, yet it is not usury, because the money being furnished at the lender's hazard, if the ship perishes, he shares in the loss.

BOTTONY, a cross bottony, in heraldry, terminates at each end in three buds, knots, or buttons, resembling, in some measure, the three-leaved grass.

BOTTS. See Oestrus.

BOUCHE *of court*, the privilege of having meat and drink at court, scot-free. This privilege is sometimes only extended to bread, beer, and wine; and was anciently in use as well in the houses of noblemen as in the king's court.

BOUGUER (Peter), in biography, a celebrated French mathematician, born at Croisci, in Lower Bretagne, in February, 1698. His father, John, was professor of hydrography, and author of "A Complete Treatise on Navigation." Young Bouguer learnt mathematics of his father, from the time he was able to speak, and thus became a proficient in those sciences while he was yet a child. He was sent very early to the Jesuits' college at Vannes, where he had the honour to instruct his regent in the mathematics, at eleven years of age. Two years after this he had a public contest with a professor of mathematics, upon a proposition which the latter had advanced erroneously; and he triumphed over him; upon which the professor, unable to bear the disgrace, left the country. Upon the death of his father, he was appointed to succeed in his office of hydrographer, after a public examination of his qualifications, being then only fifteen years of age; an occupation which he discharged with great respect and dignity at that early age. In 1727, at the age of twenty-nine, he obtained the prize proposed by the Academy of Sciences, for the best way of masting of ships. This first success of Bouguer was soon after followed by two others of the same kind; he successively gained the prizes of 1729 and 1731; the former, for the best manner of observing at sea the height of the stars, and the latter, for the most advantageous way of observing the declination of the magnetic needle, or the variation of the compass.

In 1730, he was removed from the port of Croisci to that of Havre, which brought him into a nearer connection with the Academy of Sciences, in which he obtained, in 1731, the place of associate geometrician, vacant by the promotion of Maupertuis to that of pensioner; and in 1735 he was promoted to the office of pensioner astronomer. The same year he was sent on the commission to South America, along with Messieurs Godin, Condamine, and Jussieu, to determine the measure of the degrees of the meridian, and the figure of the earth. In this painful and troublesome business, of ten years duration, chiefly among the lofty Cordelier mountains, our author determined many other new circumstances, beside the main object of the voyage; such as the expansion and contraction of metals and other substances, by the sudden and alternate changes of heat and cold among those mountains; observations on the refraction of the atmosphere from the tops of the same, with the singular phenomenon of the sudden increase of the refraction, when the star can be observed below the line of the level; the laws of the density of the air at different heights, from observations made at different points of these enormous mountains; a determination that the mountains have an effect upon a plummet, though he did not assign the exact quantity of it; a method of estimating the errors committed by navigators in determining their route; a new construction of the log for measuring a ship's way: with several other useful improvements.

Other inventions of Bouguer, made upon different occasions, were as follow: the heliometer, being a telescope with two object glasses, affording a good method of measuring the diameters of the larger planets with ease and exactness: his researches on the figure in which two lines or two long ranges of parallel trees appear: his experiments on the famous reciprocation of the pendulum; and those upon the manner of measuring the force of the light; &c. &c.

The close application which Bouguer gave to study undermined his health, and terminated his life the 15th of August, 1758, at 60 years of age. His chief works, that have been published, are, 1. "The Figure of the Earth, determined by the Observations made in South America;" 1749, in 4to. "2. "Treatise on Navigation and Pilotage;" Paris, 1752, in 4to. This work has been abridged by M. La Caille, in one volume, 8vo. 1768. 3. "A Treatise on Ships, their Construction and Motions;" in 4to. 1756. 4. "An Optical Treatise on the Gradation of Light;" first in 1729; then a new edition in 1760, in 4to. and a great number of papers inserted in the Memoirs of the Academy.

BOUNTY, a bounty in political economy, is a sum of money paid by the state for the raising or the exporting of some species of rude produce or manufacture. In this country every person who raises a certain quantity of flax is entitled to a bounty; and when corn is below a certain price, a bounty of so much per bushel is paid on its exportation.

The intention of bounties is to encourage the production of those articles on which they are paid, by securing a profitable return to the producer.

The effect of a bounty on the production of any article is, to render it cheaper in the home market—thus, if the fair or customary profit on the capital employed be 10 per cent., and the bounty amount to 5 per cent. on the capital, it is evident the grower can afford to sell the article 5 per cent. cheaper than he otherwise could.

The effect of a bounty on the exportation of any article is, to render it dearer in the home market—for by means of it the surplus of the home market can be removed on easier terms than could otherwise be possible to the foreign market, and thus a reduction of price is prevented.

But if the redundance of the home market could not be exported, and the price consequently was reduced, production would be discouraged, and the supply being more scanty, the price might be as high or higher than it is rendered by the bounty. For a more particular inquiry into the effects of a bounty on exportation see CORN LAWS.

The objection to all bounties is the following: "that every branch of trade in which the merchant can sell his goods for a price which replaces to him, with the ordinary profits of stock, the whole capital employed in preparing and sending them to market, can be carried on without a bounty. Every such branch is evidently upon a level with all the other branches of trade which are carried on without bounties, and cannot therefore require one more than they. Those trades only require bounties, in which the merchant is obliged to sell his goods for a price which does not replace to him his capital, together with the ordinary profit, or in which he is obliged to sell them for less than it really costs him to send them to market. The bounty is given in order to make up this loss, and to encourage him to continue, or perhaps to begin a trade, of which the expense is supposed to be greater than the returns, of which every operation eats up a part of the capital employed in it, and which is of such a nature, that, if all other trades resembled it, there would soon be no capital left in the country. See DRAWBACK, PREMIUM.

BOW, a weapon of offence made of steel, wood, horn, or other elastic matter, which, after being bent by means of a string fastened to its two ends, in returning to its natural state, throws out an arrow with prodigious force.

The use of the bow is, without all doubt, of the earliest antiquity. It has likewise been the most universal of all weapons, having obtained among the most barbarous and remote people, who had the least communication with the rest of mankind.

The figure of the bow is pretty much the same in all countries, where it has been used; for it has generally two inflexions or bendings, between which, in the place where the arrow is drawn, is a right line. The Grecian bow was in the shape of a Σ, of which form we meet with many, and generally adorned with gold or silver. The Scythian bow was distinguished from the bows of Greece and other nations by its incurvation, which was so great, as to form an half-moon or semicircle.

The matter of which bows were made, as well as their size, differed in different countries. The Persians had very great bows made of reeds; and the Indians had also, not only arrows, but bows made of the reeds or canes of that country; the Lycian bows were made of the cornel tree; and those of the Æthiopians, which surpassed all others in magnitude, were made of the palm-tree.

Though it does not appear that the Romans made use of bows in the infancy of their republic, yet they afterwards admitted them as hostile weapons, and employed auxiliary archers in all their wars.

In drawing the bow, the primitive Grecians did not pull back their hand towards their right ear, according to the fashion of modern ages, and of the ancient Persians, but, placing their bow directly before them, returned their hand upon their right breast. This was also the custom of the Amazons.

The bow is a weapon of offence amongst the inhabitants of Asia, Africa, and America, at this day; and in Europe, before the invention of fire arms, a part of the infantry were armed with bows.

Lewis XI. first abolished the use of them in France, introducing, in their place, the halbard, pike, and broad sword. The long bow was formerly in great vogue in England, and many laws were made to encourage the use of it. The parliament under Henry VIII. complained of the disuse of long bows, heretofore the safeguard and defence of this kingdom, and the dread and terror of its enemies.

Bow, in music, an instrument, which, being drawn over the strings of a musical instrument, makes it resound. It is composed of a small stick, to which are fastened eighty or an hundred horse hairs, and a screw, which serves to give these hairs the proper tension. In order that the bow may touch the strings briskly, it is usual to rub the hairs with rosin. The bow of the violin is now about 28 inches long.

Bow, among artificers, an instrument, so called from its figure, in use among gun-smiths, locksmiths, watch-makers, &c. for making a drill go. Among turners, it is the name of that pole fixed to the ceiling, to which they fasten the cord that whirls round the piece to be turned.

Bow *of a ship*, that part of her head, which is contained between the stern and the after-part of the fore-castle on either side; so that a ship hath two bows, the starboard and the larboard, or, as they are sometimes called, the weather and the lee bow.

BOWLING, the art of playing at bowls. The first thing to be observed in bowling is, the right choosing your bowl, which must be suitable to the ground you design to run on. Thus, for close alleys, the flat bowl is the best; for open grounds of advantage, the round byassed bowl; and for plain and level swards, the bowl that is as round as a ball. The next is to choose your ground; and lastly to distinguish the risings, fallings, and advantages of the places where you bowl.

Bowling, Bow-line, in a ship, a rope made fast to the leech or middle part of the outside of the sail: it is fastened by two, three, or four ropes, like a crow's foot, to as many parts of the sail; only the mizen bowling is fastened to the lower end of the yard. This rope belongs to all sails, except the sprit-sail and sprit-top-sails. The use of the bowling is to make the sails stand sharp or close, or by a wind.

"Sharp the bowling," is hale it taught, or pull it hard. "Hale up the bowling," that is, pull it harder forward on. "Check or ease, or run up the bowling," that is, let it be more slack.

BOWSE, in the sea language, signifies as much as to hale or pull. Thus bowsing upon a tack, is haling upon a tack. Bowse away, that is, pull away altogether.

BOWSPRIT, or **Boltsprit**, a kind of mast, resting slopewise on the head of the main stem, and having its lower end fastened to the partners of the fore-mast, and farther supported by the fore-stay. It carries the sprit-sail, sprit-top-sail, and jack-staff, and its length is usually the same with that of the fore-mast.

BOWYERS, artificers, whose employment or occupation it is to make bows. There is a company of bowyers in the city of London, first incorporated in 1623.

BOX. See Buxus.

The turner, engraver, carver, mathematical instrument, comb, and pipe makers, give a great price for this wood by weight, as well as by measure. It makes wheels or shivers, pins for blocks and pullies, pegs for musical instruments, nut-crackers, weavers' shuttles, collar-sticks, bump-sticks and dressers for shoemakers, rulers, rolling-pins, pestles, mall-balls, beetles, tops, tallies, chess-men, screws, bobbins, cups, spoons, and the strongest of all axle-trees.

The box-tree formerly grew in great plenty near Dorking, in Surry, but only a few of the large trees are now left. Box-wood is chiefly imported from the Levant, sometimes from Spain.

BOYAU, in fortification, a ditch covered with a parapet, which serves as a communication between two trenches. It runs parallel to the works of the body of the place, and serves as a line of contravallation, not only to hinder the sallies of the besieged, but also to secure the miners. But when it is a particular cut, that runs from the trenches to cover some spot of ground, it is drawn so as to be enfiladed, or scoured by the shot from the town.

BOYLE (Robert,) one of the greatest philosophers, as well as best men, that any country has ever produced, was the seventh son, and the fourteenth child, of Richard Earl of Cork, and born at Lismore, in the province of Munster, in Ireland, the 25th of January, 1626-7; the very year of the death of the learned Lord Bacon, whose plans of experimental philosophy he afterwards so ably seconded, that it was said of him, that he was the person designed by nature to succeed to the labours and inquiries of that extraordinary genius. While very young, he was instructed in his father's house to read and write, and to speak French and Latin. In 1635, when only eight years old, he was sent over to England, to be educated at Eton school. Here he soon discovered extraordinary powers of understanding, with a disposition to cultivate and improve it to the utmost.

After remaining at Eton between three and four years, his father sent him and his brother Francis, in 1638, on their travels upon the continent. They passed through France to Geneva, where they settled for some time to pursue their studies: here he resumed his acquaintance with the elements of the mathematics, which he had commenced at Eton when ten years old.

In the autumn of 1641, he quitted Geneva, and travelled through Switzerland and Italy to Venice, from whence he returned again to Florence, where he spent the winter, studying the Italian language and history, and the works of the celebrated astronomer Galileo, who died in a village near this city during Mr. Boyle's residence here.

About the end of March, 1642, he set out from Florence, visited Rome and other places in Italy, then returned to the south of France, and came back to England in 1644.

From this time Mr. Boyle's chief residence, for some years at least, was at his manor of Stalbridge, from whence he made occasional excursions to Oxford, London, &c.; applying himself with great industry to various kinds of studies, but especially to philosophy and chemistry, and seizing every opportunity of cultivating the acquaintance of the most learned men of his time. He was one of the members of that small but learned body of men, who, when all academical studies were interrupted by the civil wars, secreted themselves, about the year 1645, and held private meetings, first in London, afterwards at Oxford, to cultivate subjects of natural knowledge, upon that plan of experiment which Lord Bacon had delineated. They styled themselves then the Philosophic College; but after the restoration, when they were incorporated, and distinguished openly, they took the name of the Royal Society.

In the summer of 1654, he went to settle at Oxford, the Philosophical Society being removed from London to that place, that he might enjoy the conversation of the other learned members, his friends, who had retired thither, such as Wilkins, Wallis, Ward, Willis, Wren, &c. It was during his residence here that he improved that admirable engine the air-pump: and by numerous experiments was enabled to discover several qualities of the air, so as to lay a foundation for a complete theory. But philosophy, and inquiries into nature, though they engaged his attention deeply, did not occupy him entirely, as he still continued to pursue critical and theological studies. He had offers of preferment to enter into holy orders, by the government, after the restoration. But he declined the offer, choosing rather to pursue his studies as a layman, in such a manner as might be most effectual for the support of religion; and began to communicate to the world the fruits of these studies.

In the year 1663, the Royal Society being incorporated by King Charles II. Mr. Boyle was named one of the council; and as he might justly be reckoned among the founders of that learned body, so he continued one of the most useful and industrious of its members during the whole course of his life.

In 1688, Mr. Boyle's health declining very much, he abridged greatly his time given to conversations and communications with other persons, to have more time to prepare for the press some others of his papers, before his death; he died on the last day of December of the year 1691, in the 65th year of his age, and was buried in St. Martin's church in the Fields, Westminster, his funeral sermon being preached by Dr. Gilbert Burnet, Bishop of Salisbury; in which he displayed the excellent qualities of our author, with many circumstances of his life, &c. He represents him as being well acquainted with the whole compass of the mathematical sciences, and as well versed even in the most abtruse parts of geometry.

Mr. Boyle left also several papers behind him, which have been published since his death. Beautiful editions of all his works have been printed at London, in 5 volumes folio, and six volumes 4to. Dr. Shaw also published, in three volumes 4to., the same works, "abridged, methodized, and disposed under the general heads of Physic, Statics, Pneumatics, Natural History, Chemistry, and Medicine;" to which he has prefixed a short catalogue of his philosophical writings, according to the order of time when they were first published. The character of this great man can be only estimated by an attention to his works, reflecting, at the same time, on the state of science at the period in which he lived. He was distinguished by the comprehensiveness of his views, and the extent and variety of his researches; by indefatigable diligence, and invincible perseverance, in his collection of facts and investigation of their causes; by a total freedom from any preconceived attachment to theories and systems; by candour in discussing the opinions of others; and by fidelity and modesty in the narration of his own performances.

B QUADRO, **Quadrato**, or **Durale**, in music, called by the French b quarre, from its figure ♮ This is what we call B natural or sharp, in distinction to B mol or flat. See Flat, and

If the flat ♭ be placed before a note in the thorough bass, it intimates that its third is to be minor; and if placed with any cypher over a note in the bass, as ♭ 6, or ♭ 5, &c. it denotes, that the fifth or sixth thereto are to be flat. But if the quadro ♮ be placed over any note, or with a cypher, in the thorough bass, it has the contrary effect; for thereby the note or interval thereto is raised to its natural order.

BRABEIUM, in botany, a genus of the Polygamia Monoecia class and order. Essential character: herm. scales of the ament; corol four-parted, revolute above; stamens four; pistil one: drupe roundish; seed globular; male, scales of the ament; corol four or five parted; stamens four, inserted into the throat; style bifid, abortive. There is only one species, with its varieties, *viz.* B. stellulifolium, or African almond, rises with an upright stem, which is soft and full of pith, and covered with a brown bark. Horizontal branches are sent out at every joint, the lower ones being longest, and every tier diminishing to the top, so as to form a sort of pyramid. The flowers are produced near the ends of the shoots, coming out from between the leaves, quite round the branches, they are of a pale colour inclining to white, they appear early in the spring, and fall away without any fruit succeeding them in this country. It is a native of the country about the Cape of Good Hope.

BRACE, in architecture, a piece of timber framed in with bevil joints, the use of which is to keep the building from swerving either way. When the brace is framed into the king-pieces, or principal rafters, it is by some called a strut.

Braces, in the sea-language, are ropes belonging to all the yards of a ship, except the mizen, two to each yard, reeved through blocks that are fastened to pennants, seized to the yard arms. Their use is either to square or traverse the yards. Hence to brace the yard, is to bring it to either side. All braces come aftward on, as the main brace comes to the poop, the main-top-sail brace comes to the mizen-top, and thence to the main shrouds; the fore and fore-top-sail braces come down by the main and main-top sail stays, and so of the rest. But the mizen-bowline serves to brace to the yard, and the cross-jack braces are brought forwards to the main-shrouds when the ship sails close by a wind.

Braces, in music, are those double curves which are placed at the beginning of the staves of any composition. Their use is to bend together the harmonizing parts, and lead the eye with facility from one set of staves to another. In those scores which include a part for a keyed instrument, as the organ, harpsicord, or piano-forte, it is usual to draw a smaller brace within the great one, to include and to distinguish from the other parts of the score the two staves designed for either of those instruments.

Braces to a drum, the cords which are distended in oblique lines from the head to the bottom round the exterior of the drum, and which, by tightening or relaxing the parchment, serve to raise or flatten the tone.

BRACELET, an ornament worn on the wrist, much used among the ancients; it was made of different materials, and in different fashions, according to the age and quality of the wearer. Bracelets are still worn by the savages of Africa, who are so excessively fond of them, as to give the richest commodities, and even their fathers, wives, and children, in exchange for those made of no richer materials than shells, glass, beads, and the like.

BRACHIÆUS, in anatomy, a name given to two muscles, which are flexors of the cubitus, and distinguished by the appellations of *externus* and *internus*. See Anatomy.

BRACHMANS, a sect of Indian philosophers, known to the ancient Greeks by the name of Gymnosophists. The ancient Brachmans lived upon herbs and pulse, and abstained from every thing that had life in it. They lived in solitude, without matrimony, and without property; and they wished ardently for death, considering life only as a burden. The modern Brachmans make up one of the casts or tribes of the Banians. They are the priests of that people, and perform their office of praying and reading the law with several mimical gestures, and a kind of quavering voice. They believe, that, in the beginning, nothing but God and the water existed, and that the Supreme Being, desirous to create the world, caused the leaf of a tree, in the shape of a child playing with its great toe in its mouth, to float on the water. From its navel there issued out a flower, whence Brama drew his original, who was intrusted by God with the creation of the world, and presides over it with an absolute sway. They make no distinction between the souls of men and brutes, but say the dignity of the human soul consists in being placed in a better body, and having more room to display its faculties. They allow of rewards and punishments after this life; and have so great a veneration for cows, that they look on themselves as blessed, if they can but die with the tail of one of them in their hand. They have preserved some noble fragments of the knowledge of the ancient Brachmans. They are skilful arithmeticians, and calculate, with great exactness, eclipses of the sun and moon. They are remarkable for their religious austerities. One of them has been known to make a vow, to wear about his neck a heavy collar of iron for a considerable time: another to chain himself by the foot to a tree, with a firm resolution to die in that place: and another to walk in wooden shoes stuck full of nails on the inside. Their divine worship consists chiefly of processions, made in honour of their deities. They have a college at Banara, a city seated on the Ganges.

BRACHURUS, the name of a genus of animalcules, with tails shorter than their bodies, and no visible limbs.

BRACHYGLOTTIS, in botany, a genus of the Syngenesia Superflua class and order. Receptacle naked; down feathery; calyx cylindrical, simply equal; florets of the disk five-cleft. There are two species, natives of the South Sea Islands.

BRACHYGRAPHY, the art of short-hand writing. See Short-hand.

BRACKETS, in a ship, the small knees, serving to support the galleries, and commonly carved. Also the timbers that support the gratings in the head are called brackets.

Brackets, in gunnery, are the cheeks of the carriage of a mortar; they are made of strong planks of wood, of almost a semicircular figure, and bound round with thick iron plates; they are fixed to the beds by four bolts, which are called bed-bolts; they rise up on each side of the mortar, and serve to keep her at any elevation, by means of some strong iron bolts, called bracket-bolts, which go through these cheeks or brackets.

BRADLEJA, in botany, so named from Richard Bradley, F.R.S. first professor of botany at Cambridge, a genus of Monoecia Monadelphia class and order. Essential character: male calyx none; corol petals six, nearly equal; filaments three, with three twin anthers, female calyx none: corol six-parted, three parts interior; germ superior, with six to eight stigmas; capsules six-celled, six-valved; seeds solitary. There are three species, B. sinica, Chinese bradleja, is a shrub with leaves resembling the annona, but not of a lucid surface. The fructifications proceed from the axils of the leaves. The fruits or seed-vessels are compressed, small or bilocular, striated and hard. B. zeylanica, is a Ceylonese shrub. B. glochidium, is a shrub which grows in the islands of the Southern or Pacific Ocean.

BRADLEY, (Dr. James) a celebrated English astronomer, the third son of William Bradley, was born at Sherborne, in Gloucestershire, in the year 1692. He went to Oxford, and was admitted a commoner of Baliol College, March 15, 1710, where he took the degree of bachelor the 14th of October, 1714, and of master of arts the 21st of January 1716. His friends intending him for the church, his studies were regulated with that view; and as soon as he was of a proper age to receive holy orders, the Bishop of Hereford, who had conceived a great esteem for him, gave him the living of Bridstow, and soon after he was inducted to that of Landewy Welfry, in Pembrokeshire.

He was nephew to Mr. Pound, a gentleman well known in the learned world, by many excellent astronomical and other observations, and who would have enriched it much more, if the journals of his voyages had not been burnt at Pulo Condor, when the place was set on fire, and the English who were settled there cruelly massacred, Mr. Pound, himself very narrowly escaping with his life. With this gentleman, at Wanstead, Mr. Bradley passed all the time that he could spare from the duties of his function; being then sufficiently acquainted with the mathematics to improve by Mr. Pound's conversation. It may easily be imagined that the example and conversation of this gentleman did not render Bradley more fond of his profession, to which he had before no great attachment; he continued, however, as yet to fulfil the duties of it, though at this time he had made such observations, as laid the foundation of those discoveries which afterwards distinguished him as one of the greatest astronomers of his age. These observations gained him the notice and friendship of the Lord Chancellor Macclesfield, Mr. Newton, afterwards Sir Isaac, Mr. Halley, and of many other members of the Royal Society, into which he was soon after elected a member.

Soon after, the chair of Savilian professor of astronomy at Oxford became vacant, by the death of the celebrated Dr. John Keil, and Mr. Bradley was elected to succeed him on the 31st of October, 1721, at 29 years of age, his colleague being Mr. Halley, who was professor of geometry on the same foundation. Upon this appointment, Mr. Bradley resigned his church livings, and applied himself wholly to the study of his favourite science. In the course of his observations, which were almost innumerable, he discovered and settled the laws of the alterations of the fixed stars, from the progressive motion of light, combined with the earth's annual motion about the sun, and the nutation of the earth's axis, arising from the unequal attraction of the sun and moon on the different parts of the earth. The former of these effects is called the "aberration" of the fixed stars, the theory of which he published in 1727; and the latter, the "nutation" of the earth's axis, the theory of which appeared in 1737: so that, in the space of about ten years, he communicated to the world two of the finest discoveries in modern astronomy, which will for ever make a memorable epoch in the history of that science. See Aberration and Nutation.

In 1730, Mr. Bradley succeeded Mr. Whiteside, as lecturer in astronomy and experimental philosophy in the Museum at Oxford, which was a considerable emolument to him, and which he held till within a year or two of his death, when his ill state of health induced him to resign it. He always preserved the esteem and friendship of Dr. Halley, who, being worn out by age and infirmities, thought he could not do better for the service of astronomy, than procure for Mr. Bradley the place of regius professor of astronomy at Greenwich, which he himself had many years possessed with the greatest reputation. With this view he wrote many letters, desiring Mr. Bradley's permission to apply for a grant of the reversion of it to him, and even offered to resign it in his favour, if it should be thought necessary; but Dr. Halley died before he could accomplish this kind object. Dr. Bradley, however, obtained the place in February, 1741-2, by the interest of Lord Macclesfield, who was afterward president of the Royal Society, and upon his appointment the University of Oxford sent him a diploma of doctor of divinity.

This appointment of astronomer royal at Greenwich, which was dated the third of February, 1741-2, placed Mr. Bradley in his proper element, and he pursued his observations with unwearied diligence. However numerous the collection of astronomical instruments at that observatory, it was impossible that such an observer as Dr. Bradley should not desire to increase them, as well to answer those particular views, as in general to make observations with greater exactness. In the year 1748, therefore, he took the opportunity of the visit of the Royal Society to the observatory, annually made to examine the instruments and receive the professor's observations for the year, to represent so strongly the necessity of repairing the old instruments, and providing new ones, that the Society thought proper to make application to the king, who was pleased to order one thousand pounds for that purpose. This sum was laid out under the direction of our author, who, with the assistance of the late celebrated Mr. Graham and Mr. Bird, furnished the observatory with as complete a collection of astronomical instruments as the most skilful and diligent observer could desire.

During Mr. Bradley's residence at the Royal Observatory, the living of the church at Greenwich became vacant, and was offered to him: upon his refusing to accept it, from a conscientious scruple, "that the duty of a pastor was incompatible with his other studies and necessary engagements," the king was pleased to grant him a pension of 250*l.* over and above the astronomer's original salary from the board of ordnance, "in consideration (as the sign manual, dated the 15th February, 1752, expresses it) of his great skill and knowledge in the several branches of astronomy and other parts of the mathematics, which have proved so useful to the trade and navigation of this kingdom." A pension which has been regularly continued to the astronomers royal ever since.

About 1748 our author became entitled to Bishop Crew's benefaction of 30*l.* a year to the lecture reader in experimental philosophy at Oxford. He was elected a member of the Academy of Sciences at Berlin in 1747; of that at Paris in 1748; of that at Petersburgh in 1754; and of that of Bologna in 1757. He was married in the year 1744; but never had more than one child, a daughter.

By too close application to study and observations, Dr. Bradley became afflicted for near two years before his death with a grievous oppression on his spirits; which interrupted his useful labours. This distress arose chiefly from an apprehension that he should outlive his rational faculties: but this so much dreaded evil never came upon him. In June, 1762, he was seized with a suppression of urine, occasioned by an inflammation in the reins, which terminated his existence the 13th of July following. His death happened at Chalfont, in Gloucestershire, in the 70th year of his age, and he was interred at Minchinhampton, in the same county.

As to his character, Dr. Bradley was remarkable for a placid and gentle modesty, very uncommon in persons of an active temper and robust constitution. Although he was a good speaker, and possessed the rare but happy art of expressing his ideas with the utmost precision and clearness, yet no man was a greater lover of silence, for he never spoke but when he thought it absolutely necessary. Nor was he more inclined to write than to speak, as he has published very little; he had a natural diffidence, which made him always afraid that his works might injure his character, so that he suppressed many which might have been worthy of publication. Many of his papers have been inserted in the Philosophical Transactions.

The public character of Dr. Bradley, as a man of science and observation, is fully established by his various works. His private character was in every respect estimable. That he published so little may be ascribed to a large share of diffidence, which prevented him from soliciting that attention which at all times he could command. His observations made at the Royal Observatory, during 20 years, were comprised in 13 vols. folio and two 4to.; these were transferred in the year 1776 to the University of Oxford, on condition they should be printed and published by that learned body. In June, 1691, the Board of Longitude, seeing no prospect of their publication, passed some resolutions respecting the public right to these observations, which being transmitted to the vice chancellor, the Board was in consequence informed, that the delegates of the press in the university were proceeding with the work. The first volume was published in 1798, in a very splendid form, under the title of "Astronomical observations at Greenwich, from the year 1750 to the year 1762."

BRADS, among artificers, a kind of nails used in building, which have no spreading head as other nails have.

BRADYPUS, *the sloth*, in natural history, a genus of Mammalia, of the order Bruta. Generic character; cutting teeth, none in either jaw; canine teeth obtuse, single, longer than the grinders, placed opposite; grinders five on each side, obtuse; fore legs much longer than the hind; claws very long. See Plate II. Mammalia, fig. 6. There are three species, of which we shall give a brief account. B. tridactylus, or three-toed sloth: the general appearance of the sloth is extremely uncouth; the body is of a thick shape; the fore-legs short, the hinder ones far longer; the feet on all the legs are very small, but are armed each with three most excessively strong and large claws, of a slightly curved form, and sharp-pointed: the head is small; the face short, with a rounded or blunt snout, which is naked, and of a blackish colour; the eyes are small, black, and round; the ears rather small, flat, rounded, lying close to the head, and not unlike those of monkeys: the hair on the top of the head is so disposed as to project somewhat over the forehead and sides of the face, giving a very peculiar and grotesque physiognomy to the animal. The general colour of the hair on all parts is a greyish brown; and the hair is extremely coarse, moderately long, and very thickly covers the body, more especially about the back and thighs. A remarkable character as to colour, in this species, is a wide patch or space on the upper part of the back, of a bright ferruginous, or rather pale orange colour, spotted on each side with black, and marked down the middle with a very conspicuous black stripe, wide at its origin, and gradually tapering to its extremity; it reaches more than half way down the back, and terminates in a sort of trifid mark. The tail is nearly imperceptible, being so extremely short as to be concealed from view by the fur.

The sloth feeds entirely on vegetables, and particularly on leaves and fruit. Its voice is said to be so inconceivably singular, and of such a mournful melancholy, attended, at the same time, with such a peculiarity of aspect, as at once to excite a mixture of pity and disgust; and it is added, that the animal makes use of this natural yell as its best mode of defence, since other creatures are frightened away by the uncommon sound. This, however, is far from being its only refuge; for so great is the degree of muscular strength which it possesses, that it is capable of seizing a dog with its claws, and holding it, in spite of all its efforts to escape, till it perishes with hunger; the sloth itself being so well calculated for supporting abstinence, that the celebrated Kircher assures us of its power in this respect, having been exemplified by the very singular experiment of suffering one, which had fastened itself to a pole, to remain in that situation, without any sustenance, upwards of forty days. This extraordinary animal is an inhabitant of the hotter parts of South America. It is nearly as large as a middle sized dog.

B. Didactylus, or two-toed sloth, is also a native of South America; and it is asserted, on good authority, that it is likewise found in some parts of India, as well as in the Island of Ceylon. In its general appearance, as well as in size, it bears a considerable resemblance to the former species: it is, however, somewhat more slender in its shape, covered with smoother or less coarse and harsh hair, and is of a more uniform or less varied tinge; and, in particular, is strikingly distinguished, as a species, by having only two claws on the fore-feet; it is also a much more active animal, and, even when imported into Europe, has been known, according to the testimony of the Count de Buffon, to ascend and descend from a tall tree several times in a day; whereas the three-toed sloth with difficulty performs that operation in a whole day, and can scarcely crawl a few hundred yards in the space of many hours.

B. Ursinus, or ursine sloth, is by far the largest species: it is a native of India, and has been but lately introduced to the knowledge of European naturalists. It was brought from the neighbourhood of Patna in Bengal. This animal has, at first sight, so much of the general aspect of a bear, that it has actually been considered as such by some observers: but it is no otherwise related to the bear than by its size and habit, or mere exterior outline. It is about the size of a bear, and is covered all over, except on the face, or rather the snout, which is bare and whitish, with long shaggy black hair, which on the neck and back is much longer than elsewhere: on the forepart of the body the hair points forwards; on the hinder part backwards: the eyes are very small; the ears rather small, and partly hid in the long hair of the head: it is totally destitute of incisores, or front teeth; in each jaw there are two canine teeth of a moderate size: the nose or snout is of a somewhat elongated form; it also appears as if furnished with a sort of transverse joint, or internal cartilage, which admits of a peculiar kind of motion in this part. It is a gentle and good natured animal; it feeds chiefly on vegetables and milk, is fond of apples, and does not willingly eat animal food, except of a very tender nature, as marrow, which is readily sucked from a bone presented to it. Its motions are not, as in the two former species, slow and languid, but moderately lively; and it appears to have a habit of turning itself round and round every now and then, as if for amusement, in the manner of a dog when lying down to sleep. It is said to have a propensity to burrowing under the ground.

BRAG, an ingenious and pleasant game at cards, wherein as many may partake as the cards will supply; the eldest hand dealing three to each person at one time, and turning up the last card all round. This done, each gamester puts down three stakes, one for each card. The first stake is won by the best card turned up in the dealing round; beginning from the ace, king, queen, knave, and so downwards. When cards of the same value are turned up to two or more of the gamesters, the eldest hand gains; but it is to be observed, that the ace of diamonds wins, to whatever hand it be turned up.

The second stake is won by what is called the brag, which consists in one of the gamsters challenging the rest to produce cards equal to his: now it is to be observed that a pair of aces is the best brag, a pair of kings the next, and so on; and a pair of any sort wins the stake from the most valuable single card. In this part consists the great diversion of the game; for, by the artful management of the looks, gestures, and voice, it frequently happens, that a pair of fives, trays, or even duces, out-brags a much higher pair, and even from pairs royal, to the no small merriment of the company. The knave of clubs is here a principal favourite, making a pair with any other card in hand, and with any other two cards a pair royal.

The third stake is won by the person, who first makes up the cards in his hand one and thirty; each dignified card going for ten, and drawing from the pack as usual in this game.

BRAHE (Tycho), a celebrated astronomer, descended from a noble family, originally of Sweden, but settled in Denmark, was born the 14th of December, 1546, at Knudstrop, in the county of Schonen, near Helsinbourg. He was taught Latin when seven years old, and studied five years under private tutors. His father dying while he was very young, his uncle, George Brahe, adopted him, and sent him in 1559 to study philosophy and rhetoric at Copenhagen. The great eclipse of the sun, on the 21st of August, 1560, happening at the precise time the astronomers had foretold, he began to consider astronomy as something divine; and purchasing the tables of Stadius, he gained some notion of the theory of the planets. In 1562 he was sent by his uncle to Leipsic to study the law, where his acquirements gave manifest indications of extraordinary abilities. His natural inclination, however, was to the study of the heavens, to which he applied himself so assiduously, that, notwithstanding the care of his tutor to keep him close to the study of the law, he made use of every means in his power for improving his knowledge of astronomy; he purchased with his pocket money whatever books he could meet with on the subject, and read them with great attention, procuring assistance in difficult cases from Bartholomew Schultens, his private tutor; and having procured a small celestial globe, he took opportunities, when his tutor was in bed, and when the weather was clear, to examine the constellations in the heavens, to learn their names from the globe, and their motions from observations.

After a course of three years study at Leipsic, his uncle dying, he returned home in 1565. In this year, at a wedding-feast, a difference arising between Brahe and a Danish nobleman, they fought, and our author had part of his nose cut off by a blow: a defect which he so artfully supplied with one made of gold and silver, that it was scarcely perceivable. About this time he began to apply himself to chemistry, proposing nothing less than to obtain the philosopher's stone.

In 1571 he returned to Denmark, and was favoured by his maternal uncle Steno Billes, a lover of learning, with a convenient place at his castle of Herritzvad near Knudstrop, for making his observations, and building a laboratory. And here it was he discovered, in 1573, a new star in the constellation Cassiopeia. But soon after, his marrying a country girl, beneath his rank, occasioned so violent a quarrel between him and his relations, that the king was obliged to interpose to reconcile them.

In 1574, by the king's command, he read lectures at Copenhagen on the theory of the planets. The year following he began his travels through Germany, and proceeded as far as Venice. He then resolved to remove his family, and settle at Basil; but Frederick the Second, King of Denmark, being informed of his design, and unwilling to lose a man who was capable of doing so much honour to his country, he promised to enable him to pursue his studies, and bestowed upon him for life the island of Huen in the Sound, and promised that an observatory and laboratory should be built for him, with a supply of money for carrying on his designs: and accordingly, the first stone of the observatory was laid the 8th of August 1576, under the name of Uranibourg. The king also gave him a pension of 2000 crowns out of his treasury, a fee in Norway, and a canonry of Roshild, which brought him in 1000 more. This situation he enjoyed for the space of about twenty years, pursuing his observations and studies with great industry: here he kept always in his house ten or twelve young men, who assisted him in his observations, and whom he instructed in astronomy and mathematics. Here also he received a visit from James the Sixth, King of Scotland, afterwards James the First of England, having come to Denmark to espouse Anne, daughter of Frederick the Second. James made our author some noble presents, and wrote a copy of Latin verses in his praise.

Brahe's tranquillity, however, in this happy situation was at length fatally interrupted. Soon after the death of King Frederick, by the aspersions of envious and malevolent ministers, he was deprived of his pension, fee, and canonry, in 1596. Being thus rendered incapable of supporting the expenses of his establishment, he quitted his favourite Uranibourg, and withdrew to Copenhagen, with some of his instruments, and continued his astronomical observations and chemical experiments in that city, till the same malevolence procured from the new King, Charles the Fourth, an order from him to discontinue them. This induced him to fall upon means of being introduced to the Emperor Rodolphus, who was fond of mechanism and chemical experiments: and to smooth the way to an interview, Tycho now published his book, "Astronomia instaurata Mechanica," adorned with figures, and dedicated it to the Emperor. That prince received him at Prague with great civility and respect; gave him a magnificent house, till he could procure one for him more fit for astronomical observations; he also assigned him a pension of 3000 crowns; and promised him a fee for himself and his descendants. Here then he settled in the latter part of 1598, with his sons and scholars, and among them the celebrated Kepler, who had joined him. But he did not long enjoy this happy situation, for about three years after he died on the 24th of October, 1601, of a retention of urine, in the 55th year of his age, and was interred in a very magnificent manner in the principal church at Prague, where a noble monument was erected to him; leaving besides his wife, two sons and four daughters. On the approach of death he enjoined his sons to to take care that none of his works should be lost; exhorted the students to attend closely to theirs exercises; and recommended to Kepler the finishing of the Rudolphine Tables, which he had constructed for regulating the motion of the planets.

Brahe's skill in astronomy is universally known; and he is famed for being the inventor of a new system of the planets, which he endeavoured, though without success, to establish on the ruins of that of Copernicus. He was very credulous with regard to judicial astrology and presages: if he met an old woman when he went out of doors, or a hare upon the road on a journey, he would turn back immediately, being persuaded that it was a bad omen: also, when he lived at Uranibourg, he kept at his house a madman, whom he placed at his feet at table, and fed himself; for as he imagined that every thing spoken by mad persons presaged something, he carefully observed all that this man said; and because it sometimes proved true, he fancied it might always be depended on. He was of a very irritable disposition: a mere trifle put him in a passion: and against persons of the first rank, whom he thought his enemies, he openly discovered his resentment. He was very apt to rally others, but highly provoked when the same liberty was taken with himself. The principal part of his writings are:

1. An account of the New Star which appeared Nov. 11th, 1572, in Cassiopeia; Copenh. 1573, in 4to. 2. Another treatise on the New Phenomena of the Heavens. In the first part of which he treats of the restitution, as he calls it, of the sun and of the fixed stars. And in the second part, of a new star which had then made its appearance. 3. A collection of Astronomical Epistles; printed in 4to. at Uranibourg, in 1596; Nuremberg in 1602; and at Frankfort in 1610. It was dedicated to Maurice Landgrave of Hesse; because there are in it a considerable number of letters of the Landgrave William, his father, and of Christopher Rothmann, the mathematician of that prince, to Tycho, and of Tycho to them. 4. The Rudolphine Tables; which be had not finished when he died; but were revised and published by Kepler, as Tycho had desired. 5. An accurate Enumeration of the Fixed stars; addressed to the Emperor Rodolphus. 6. A complete Catalogue of 1000 of the Fixed Stars; which Kepler has inserted in the Rudolphine Tables. 7. "Historia Cœlestis," or a History of the Heavens, in two parts: the first contains the observations he had made at Uranibourg, in sixteen books; the latter contains the observations made at Wandesburg, Wittenburg, Prague, &c. in four books.

The apparatus of Tycho was purchased by the Emperor Rodolphus for 22,000 crowns. It remained, however, useless and concealed till the troubles of Bohemia, when the army of the Elector Palatine plundered them, and in the true spirit of barbarism breaking some of them, and applying others to purposes for which they were never designed. The great celestial globe of brass was preserved, carried from Prague, and deposited with the Jesuits of Naysis in Silesia, whence it was afterwards taken, in the year 1633, and placed in the Hall of the Royal Academy at Copenhagen.

BRAIL, or **Brails**, in a ship, are small ropes made use of to furl the sails across; they belong only to the two courses and the mizen-sail; they are reeved through the blocks, seized on each side the ties, and come down before the sail, being at the very skirt thereof fastened to the cringles; their use is, when the sail is furled across, to hale up its bunt, that it may the more easily be taken up or let fall. Hale up the brails, or brail up the sail, that is, hale up the sail, in order to be furled or bound close to the yard.

BRAIN, in anatomy, that soft white mass inclosed in the cranium or skull, in which all the organs of sense terminate, and in which the soul was formerly supposed principally to reside. See Anatomy.

The brain and nerves are the instruments of sensation, and even of motion; for an animal loses the power of moving a part the instant that the nerves which enter it are cut. The brain and nerves have a strong resemblance to each other; and it is probable that they agree also in their composition. But hitherto no attempt has been made to analyse the nerves. The brain consists of two substances, which differ from each other somewhat in colour, but which, in other respects, seem to be of the same nature. The outermost matter, having some small resemblance in colour to wood-ashes, has been called the cineritious part; the innermost has been called the medullary part. Brain has a soft feel, not unlike that of soap; its texture appears to be very close; its specific gravity is greater than that of water. When brain is kept in close vessels, so that the external air is excluded, it remains for a long time unaltered. Fourcroy filled a glass vessel almost completely with pieces of brain, and attached it to a pneumatic apparatus; a few bubbles of carbonic acid gas appeared at first, but it remained above a year without undergoing any farther change. This is very far from being the case with brain exposed to the atmosphere. In a few days (at the temperature of 60°) it exhales a most detestable odour, becomes acid, assumes a green colour, and very soon a great quantity of ammonia makes its appearance in it. Experiments show, that, exclusive of the small proportion of saline ingredients, brain is composed of a peculiar matter, differing in many particulars from all other animal substances, but having a considerable resemblance in many of its properties to albumen. Brain has been compared to a soap; but it is plain that the resemblance is very faint, as scarcely any oily matter could be extricated from brain by Fourcroy, though he attempted it by all the contrivances which the present state of chemistry suggested; and the alkaline portion of it is a great deal too small to merit any attention.

BRAKE, in naval affairs, the handle by which a ship's pump is usually worked; it operates by means of two iron bolts thrust through the inner end of it, one of which rolling across two cheeks, in the upper end of the pump, serves as a fulcrum for the brake, supporting it between the cheeks. The other bolt connects the extremity of the brake to the pump spear, which draws up the box or piston charged with the water in the tube.

BRAN, the skins or husks of corn, especially wheat ground, separated from the flour by a sieve or boulter.

It is of wheat-bran that starch-makers make their starch. The dyers reckon bran among the non-colouring drugs, and use it for making, what they call, the sour waters, with which they prepare their several dyes.

BRANCH, in botany, an arm of a tree, or a part, which, sprouting out from the trunk, helps to form the head or crown thereof.

Branch is likewise a term used in genealogy and anatomy. Thus we say, the branch of a family, the branch of an artery, the branch of a vein.

BRANCHIÆ, *gills*, in the anatomy of fishes, the parts corresponding to the lungs of land animals, by which fishes take in and throw out again a certain quantity of water, impregnated with air. All fishes, except the cetaceous ones and the petromyzum, are furnished with these organs of respiration; which are always eight in number, four on each side the throat. That next the heart is the least, the rest increasing in order as they stand near the head of the fish.

Each of these gills is composed of a bony lamina, in form of a semicircle, for the most part; and on its convex side stand the leaves or lamellæ, like so many sickles. The whole convex part of the lamellæ is beset with hairs, which are longest near the base, and decrease gradually as they approach towards the point. There are also hairs on the concave side of the lamellæ, but shorter than the others, and continued only to its middle.

The convex side of one lamina is fitted into the concave side of the next superior one; and all of them are connected together by means of a membrane, which reaches from their base half way their height, where it grows thicker, and in some measure resembles a rope. The rest of the lamina is free, and terminates in a very fine and flexible point.

As to the use of these gills, they seem to be designed to receive the blood protruded from the heart into the aorta, and convey it into the extremities of the lamellæ; from whence, being returned by veins, it is distributed over the body of the fish.

BRANCHIONUS, in natural history, a genus of vermes, of the order Infusoria: the character is, body contractile, covered with a shell, and furnished at the head with ciliate rotary organs. There are 12 species: the B. urceolaris is bell-shaped, with the shell many toothed at the tip, and rounded at the base; tail long, and bifid at the end. It is found frequently in stagnant water, appearing to the naked eye as a small white speck; rotary double organ, which it can protrude and conceal at pleasure. B. striatus, univalve, with an ovate striate shell, six-toothed at the tip, and entire at the base; without tail. It is found in salt water; pellucid, crystalline, truncate on the fore part, and rounded behind; shell varying in form, with 12 longitudinal ribs.

BRANCHIOSTEGOUS, in natural history, according to the Linnæan system, it is the fifth order of fishes, having gills destitute of bony rays. There are ten genera, *viz.*

Balistes
Centriscus
Cyclopterus
Diodon
Lophius
Mormyrus
Ostracion
Pegasus
Syngnathus
Tetrodon.

Most of these are by Dr. Shaw placed among the Cartélaginei.

BRANDY, a spirituous liquor, produced by the distillation of wines of all kinds, and, properly speaking, by no other fermented liquor; though the purely spirituous part of all fermented vinous liquors procured by distillation is essentially the same, and therefore an infinite variety of imitations of the intermediate products of distillation may be produced, by adding flavouring and colouring matters to any kind of pure spirit. Brandy is prepared in many of the wine countries of Europe, and, with particular excellence, in Languedoc, in Anjou, whence the well-known Cogniac brandy, and in other parts of the south of France.

Though every wine will give a certain portion of brandy by distillation, it is not every kind that can be used with advantage. In general, the strong heavy wines are to be preferred. Those that do not yield a sixth of their quantity of spirit, are not worth the expense of working. The apparatus is composed of three parts; the alembic, or boiler, the capital fitted on the top of the boiler to receive the spirituous vapour, and the serpentine, or worm, a convoluted pipe, fitting to the beak of the alembic, and immersed in water, in which the vapour is condensed, and flows out at the bottom, in the form of distilled spirit. In distilling, care should be taken not to urge the fire too much at first, otherwise the wine boils up into the capital, and comes over into the worm, mixing with and fouling the spirit. In general, the slower the process, and the smaller the stream of spirit from the worm-pipe, the finer and better is the brandy. The distillers make a distinction between the former and latter runnings of the spirit. What first comes over has the strongest, richest, and highest flavour, and this is gradually lessened, and the spirit becomes more and more watery to the end. Therefore, when the brandy becomes weak, the portion already distilled is set apart, and the remainder is collected in a separate vessel, and is called seconds or feints, in the term of British distillers, and is not immediately fit for use, but is re-distilled with fresh wine in the next process, being still too valuable to be lost. Brandy is naturally clear and colourless as water; for the different shades of colour which it has in commerce arise partly from the casks in which it is kept, but chiefly from the addition of burnt sugar, saunders wood, and other colouring matters, that are intentionally added by the manufacturer, and which appear to do neither good nor harm to the quality of the spirit.

There are several ways of judging of the strength of the spirit. The following is also much used by the dealers; a phial is filled three-quarters with the brandy stopped with the thumb, and suddenly knocked with some force against the knee. This raises a froth on the surface, and by the size and durability of the bubbles, a good idea may be formed of the strength of the liquor, by those who are in the constant habit of examining samples. This is, however, as liable to error as the trial with gunpowder, burning, &c.; for it is well known, that certain additions may be made to brandy which will very much alter the frothing. After all that has been done, it is still a difficult problem to determine, with perfect accuracy, the strength of all kinds of made spirits, by any shorter method than that of distillation, though the improved hydrometers answer most of the purposes of trade and revenue. The strength of the spirit, of course, depends on the strength of the wine with which it is made; and this again depends on the quantity of saccharine mucilage contained in the must or grape-juice, and the perfection of the fermentation. Generally speaking, the wines of hot climates furnish much more spirit than those of colder; and sweet, rich, well-ripened grapes give much more than the cold, sour, watery fruits. The richest wines furnish as much as a third of spirit; and the general average of the wines in the south of France and Spain is stated to be, by Chaptal, about a fourth. On the other hand, some of the northern wines (though perfect as wines) give no more than a fifteenth of spirit. The manufacture of brandy in other countries very closely resembles the French process which we have just described. Thus in Spain, the still is filled to four-fifths of its contents with wine, the capital luted on, a fire kindled, and in about an hour and a half the spirit begins to come over. About a fifth of the entire quantity of wine is proof spirit, in which olive-oil sinks, and comes over fit to be used, without farther process; and as much of inferior and weaker spirit comes over afterwards, which is re-distilled and rectified. When the wines are old, heavy, and oily, and a fine clear spirit is wanted at once, water is added to the wine before distillation, to keep down the oil. The principal distilleries in Spain are in Catalonia.

BRASS, in the arts, a metal much used in various articles of manufacture; it is compounded of zinc and copper, in the proportion of one part of zinc to three of copper. It is of a fine yellow colour, and more fusible than copper, and less liable to tarnish from exposure to the atmosphere. It possesses likewise a considerable degree of malleability and ductility, and can be beat into thin leaves, and drawn into fine wire. Its specific gravity is greater than the mean specific gravity of the two metals. See ZINC.

Brass is manufactured in many countries; but no where more extensively and better than in England, in which both the materials are in great abundance. The ores of zinc are several species of calamine and of blende, called by the miners *Black Jack*, which are found abundantly in Devonshire, Derbyshire, and North Wales, generally accompanying lead ores. These are chiefly oxides, or carbonated oxides of zinc, and require a previous calcination before they are fit for brass-making. At Hollywell, in Flintshire, the calamine, which is received raw from the mines in the neighbourhood, is first pounded in a stamping-mill, and then washed and sifted in order to separate the lead, with which it is largely admixed. It is then calcined on a broad, shallow, brick hearth, over an oven heated to redness, and frequently stirred for some hours. In some places a conical pile is composed of horizontal layers of calamine alternating with layers of charcoal, the whole resting on a layer of wood in large pieces, with sufficient intervals for the draught of air. It is then kindled, and the stack continues to burn till the calamine is thoroughly calcined. The calamine, thus prepared, is then ground in a mill, and at the same time mixed with about a third or a fourth part of charcoal, and is then ready for the brass-furnace. The brass-furnace has the form of the frustrum of a hollow cone, or a cone with the apex cut off horizontally. At the bottom of the furnace is a circular grate, or perforated iron plate, coated with clay and horse dung, to defend it from the action of the fire. The crucibles stand upon the circular plate, forming a circular row, with one in the middle. The fuel, which in England is coal, is thrown round the crucibles, being let down through the upper opening or smaller end of the cone; over this opening is a perforated cover, made of fire-bricks and clay, and kept together with bars of iron, so as to fit closely. This cover serves to regulate the heat in the following manner: the draught of air is formed through an under ground vault to the ash-hole, thence through the grate and round the crucibles, and through the smaller upper opening into an area where the workmen stand, which is covered by a large dome, and a chimney to convey the smoke into the outer air. When the draught is the strongest, and the heat is required of the greatest intensity, the cover is entirely removed, and the flame then draws through the upper opening of the furnace to a considerable height into the outer brick dome: when the heat is to be lessened, the cover is put on, which intercepts more or less of the draught from the furnace, as more or fewer of the holes of the cover are left unstopped. The crucibles are charged with the mixed calamine and charcoal, together with copper clippings and refuse bits of various kinds, and sometimes brass clippings also, most of which are previously melted and run into a small sunk cistern of water, through a kind of cullender, which divides the metal into globules, like shot. Powdered charcoal is put over all, and the crucibles are then covered and luted up with a mixture of clay or loam and horse dung. The time required for heating the crucibles and completing the process varies considerably in different works, being determined by custom, by the quantity of materials, the size of the crucibles, and especially the nature of the calamine. In the great way, from 10 to 24 hours are required. At Holly-well, in Flintshire, about twenty-four hours are taken.

In the laboratory, brass may be made very well in the small way in a short time. Put into a crucible a mixture of calamine and charcoal, bury it in the requisite proportion of copper shot, cover the whole with charcoal powder, lute on a cover to the crucible, and heat slowly in a wind furnace for half an hour, till the zinc begins to burn off in a blue flame round the top of the crucible: then raise the fire and heat briskly for half an hour longer. This process of cementation is also shewn by the following management. Put the mixture of calamine and charcoal into a crucible, cover it with a thin layer of clay, over which, when dry, lay a thin plate of copper, cover the whole with fine charcoal powder, and lute on a cover to the crucible. Apply heat gradually, and the vapour of the reduced zinc will rise through the floor of clay, penetrate the red hot copper plate above it, and gradually convert it into brass, which at the end of the operation will be found lying melted on the stratum of clay. The increase of weight gained by the copper in this operation will afford a good practical test of the goodness of the calamine, and its fitness for brass-making in the great way. The most important properties of brass, compared with copper, are the following: the colour of brass is much brighter and more approaching to that of gold; it is more fusible than copper; less subject to rust, and to be acted upon by the vast variety of substances which corrode copper with so much ease; and it is equally malleable when cold, and more extensible than either copper or iron, and hence is well fitted for fine wire. Brass, however, is only malleable when cold. Hammering is found to give a magnetic property to brass, perhaps, however, only arising from the minute particles of iron beaten off the hammer during the process, and forced into the surface of the brass; but this circumstance makes it necessary to employ unhammered brass for compass-boxes, and similar apparatus. The expansion of brass has been very accurately determined, as this metal is most commonly used for mathematical and astronomical instruments, where the utmost precision is required. Mr. Smeaton found that twelve inches in length of cast brass, at 32°, expanded by 180 degrees of heat (or the interval from freezing to boiling water) 225 ten thousandth parts of an inch. Brass wire under the same circumstances expanded 232 parts; an alloy of 16 of brass with 1 of tin expanded 229 parts. The expansion of hammered copper is only 204 such parts; but that of zinc is 253: so that brass holds a middle place in this respect between its two component metals.

Analysis shews a vast variety in the proportions of the different species of brass used in commerce. In general, the extremes of the highest and lowest proportions of zinc are from 12 to 25 per cent of the brass. Even with so much as 25 per cent. of zinc, brass if well manufactured, is perfectly malleable, though zinc itself scarcely yields to the hammer. Mr. Dizé analyzed a specimen of remarkably fine brass made at Geneva, for the purpose of escapement wheels, and the nicer parts of watch-making, the perfect bars of which bear a very high price. This metal unites great beauty of colour to a very superior degree of ductility. It was found to consist of 75 of copper with 25 of zinc, and probably too the copper was Swedish, or some of the finer sorts. The common brass of Paris seems to contain about 13 per cent. of zinc, the English probably more. The uses of brass are very numerous. It is applicable to a great variety of purposes, is easily wrought by casting and hammering, and by the lathe; its wire is eminently useful, and it takes a high and very beautiful polish. The appearance of brass is given to other metals, by washing them with a yellow laquer or varnish, a substitution often very much to the detriment of the manufactured article. Many other yellow alloys of copper are used, such as bronze, bell-metal, &c. most of which are triple compounds, and will be noticed under the article COPPER.

BRASSICA, in botany, a genus of the Tetradynamia Siliquosa class and order. Natural order of Siliquosa, Cruciformes. Cruciferæ, Jussieu. Essential character: calyx erect, converging; seeds globular; a gland between the shorter stamens and the pistil, and between the longer and the calyx. There are sixteen species, among which are the various kinds of cabbages, bore-coles; brocolis, and turnips. To give a short account only of this important genus would exceed the limits of our work; we can therefore refer the reader with pleasure to Dr. Rees's New Cyclopedia, where he will find, under the words BRASSICA and CABBAGE, every information he can desire, and almost every thing that can be interesting on these subjects to the botanist, the gardener, and the farmer.

BRATHYS, in botany, a genus of the Polyandria Pentagynia class and order. Natural order, Rotaceæ. Hyperica, Jussieu. Essential character: calyx five-leaved; petals five; nectary none; capsule one-celled, many-seeded. There is but one species; *viz.* B. Juniperina, a shrub between heath and juniper, very branching and upright, the branches covered with leaves; leaves opposite, very much crowded, acerose, an inch long, acute, unarmed, evergreen; flowers terminating the branches, several together, sessile. It is found in New Granada.

BRAUNSPATH, *pearl-spar*, in mineralogy, is milk-white, though passing, by different shades to the brownish red; it occurs generally crystallized, and the forms of its crystals are the same as certain varieties of calcareous spar. Its primitive figure is a rhomboid, exactly corresponding with that of calcareous spar. It is found of other figures, which are described particularly by Hauy. The external lustre is more or less shining with a pearly lustre; but, when in the first state of decomposition, it has usually a variegated semi-metallic appearance: it is a little harder than calcareous spar: the specific gravity, according to Brisson, is 2.83; but the Isabella yellow variety has been found to be only 2.4. Before the blow-pipe it crackles and falls to pieces, and becomes of a brownish black colour, but does not melt; with borax it runs into a frothy flag; it effervesces with acids when pulverized. The massive variety, when calcined and mixed with sand, forms a strong and valuable cement, which sets quickly, and is impenetrable to water. The constituent parts are,

Carbonate of lime . . .	50
Oxide of iron	20
Oxide of manganese . .	28
	100

It occurs chiefly in veins, accompanied by calcareous spar, galenablende, pyrites, and various ores of silver. It is found in the mines of Norway, Germany, Sweden, France, and in some parts of England and Wales.

BRAWN, the flesh of a boar soused or pickled; for which end the boar should be old; because the older he is, the more horny will the brawn be.

BRAZIL *wood*, in the arts. The tree which bears this wood is the cæsalpina crista. The wood is very hard, takes a high polish, and is so heavy as to sink in water. When chewed it gives a sweetish taste. It much resembles in appearance red saunders wood, but differs from it essentially in readily giving out its colour to water, which saunders wood does not.

Brazil wood is valuable for the beautiful orange and red colours, in various shades, which it furnishes to the dyer, but the colour is naturally very fugitive, though it may be to a certain degree fixed by various mordants. When raspings of Brazil wood are boiled for some time in water, they give a fine red decoction. The residue appears black, but alkalies will continue to extract a colour from it after the action of water is exhausted. Spirit of wine and ammonia also extract a colour with great facility, which is somewhat deeper than the watery decoction. A decoction of Brazil wood is readily turned of a violet or purple blue by alkalies, and this change is produced by so very minute a quantity, as to furnish a chemical test of the presence of alkalies of very great utility. According to Bergmann, 10 grains of crystallized carbonate of soda, which contains no more than about 2.15 grains of mere alkali, dissolved in something more than 5.5 English pints of water, give a sensible purple tinge to paper reddened by Brazil wood. There is, however, some ambiguity in this test, as the same change is produced by a solution of lime or magnesia in carbonic acid and water, a very frequent occurrence in most natural waters. Evaporating the water for some time will distinguish whether the change on brazil wood is produced by an alkali, or a carbonated earth; for, if by the former, the purple will be more intense in the concentrated water, as it now holds a greater proportion of alkali; but if by a carbonated earth, the effect will be lost, as the boiling expels the loose carbonic acid, and precipitates the carbonated earth which it held in solution. The effects of the solutions of tin and alum on brazil wood are the most important to the dyer. Alum added to the watery decoction of the wood gives a copious fine red precipitate, inclining to crimson, and subsiding slowly. The supernatant liquor also retains the original red colour of the decoction, but if enough of alkali is added to decompose the alum, its earth falls down, and carries with it nearly all the remaining colouring matter of the wood. In this way a fine crimson lake, imitating the cochineal carmine, may be prepared, which therefore consists of alumine, intimately combined with the colouring matter of the wood a little heightened. Nitro-muriate of tin added to the decoction separates the whole of the colouring matter, which falls down in great abundance in union with the oxide of tin, and the liquor remains colourless.

The solutions of iron blacken the decoction or infusions of brazil wood, shewing the presence of the gallic acid. Many of the other metallic solutions act similarly to that of tin, in forming lakes, consisting of the colouring matter of the wood united with the metallic oxide of the solution employed. See Dyeing.

BRAZING, the soldering or joining two pieces of iron together by means of thin plates of brass melted between the pieces that are to be joined. If the work be very fine, as when two leaves of a broken saw are to be brazed together, they cover it with pulverized borax, melted with water, that it may incorporate with the brass powder which is added to it; the piece is then exposed to the fire without touching the coals, and heated till the the brass is seen to run.

Brazing is also used for the joining two pieces of iron together by beating them hot, the one upon the other, which is used for large pieces by farriers; this is more properly welding.

BREACH, in fortification, a gap made in any part of the works of a town by the cannon or mines of the besiegers, in order to make an attack upon the place. To make the attack more difficult, the besieged sow the breach with crow feet, or stop it with a chevaux de frize. A practicable breach is that where the men may mount and make a lodgment, and ought to be fifteen or twenty fathoms wide. The besiegers make their way to it by covering themselves with gabions, earth-bags, &c.

Breach, in a legal sense, is where a person breaks through the condition of a bond or covenant, on an action upon which the breach must be assigned; and this assignment must not be general, but particular; as in an action of covenant for not repairing houses, it ought to be assigned particularly what is the want of reparation; and in such certain manner, that the defendant may take an issue.

BREAD is a light porous spongy substance, prepared by fermentation and baking from the flour of certain farinaceous seeds, especially wheat, and is the principal sustenance of man in the temperate regions of the northern hemisphere.

When flour is kneaded with water, it forms a tough paste, called dough, which, if kept in a warm place, swells, becomes spongy, and filled with a number of air-bubbles: in this state it is called leaven: and this leaven, if incorporated with fresh dough, will bring the whole into a fermenting state much more speedily and uniformly, than if the mass was exposed to spontaneous decomposition. But though leavened bread is perfect in every other respect, it always retains a slightly acidulous flavour from the leaven by which it is fermented: for it is impossible to carry the fermentation of the gluten to a sufficient extent to change it into leaven, without at the same time exciting the acid fermentation in the sugar of the flour. It was therefore a very important improvement in the art, and one which is attributable to the English bakers, to substitute yeast, or the froth of malt liquor in a state of fermentation, to leaven; for the former not only communicates no unpleasant flavour to bread, but is also a more speedy ferment, and by acting first on the gluten of the flour produces the desired effect, before any acid has time to be evolved from the other ingredients. The process of making common bread is extremely simple, though its perfect success depends considerably on a kind of knack in manipulation, which cannot be described by words. It is of essential consequence, that the flour and yeast should be mixed together with perfect accuracy, in order that the whole mass may be equally fermented, and that this action may commence in every part at the same time. Now, though in the making of a single loaf this may easily be effected at one continued process, yet, where a considerable quantity of bread is to be made at once, this is impracticable. See Baking.

The changes produced upon dough by baking are very remarkable, nor can they in any degree be attributed to evaporation, since the loss of weight never ought to exceed $\frac{1}{30}$, and is very often not greater than $\frac{1}{60}$. In the first place the progress of fermentation is entirely stopped: the bread may be kept for several days without experiencing any alteration, and the first sign of spontaneous change is its becoming mouldy. Secondly, the tenacious ductility of the dough and its compact texture are exchanged for a moderately firm, and slightly elastic consistence, and a very spongy texture, in consequence of the alterations produced in the gluten by heat and moisture. Thirdly, the fecula or starch, which was merely diffused through the dough, without being in any degree affected by the panary fermentation, is combined during the baking with a portion of water into a stiff jelly, like common starch when boiled with water, and thus renders the bread considerably more transparent than dough, as well as more digestible. Rye and barley are the only substances, besides wheat, that are capable of being made into bread, because they alone contain gluten enough to admit of being formed into a moderately tenacious paste with water. Even in these, however, the proportion of gluten is too small to afford light bread without the use of an acid ferment, to disengage the proper quantity of carbonic acid; so that they can never, for the purpose of the baker, be at all comparable to wheaten flour.

Bread *fruit-tree*. See Artocarpus.

Bread *nut-tree*. See Brosimum.

Bread *room*, in a ship, that destined to hold the bread or biscuit. The boards of the bread room should be well joined and caulked, and even lined with tin plates or mats. It is also proper to warm it well with charcoal for several days before the biscuit is put into it; since nothing is more injurious to the bread than moisture.

BREADTH, in geometry, one of the three dimensions of bodies, which, multiplied into their length, constitutes a surface.

BREAKERS, in maritime affairs, a name given to those billows that break violently over rocks lying under the surface of the sea. They are easily distinguished, both by their appearance and sound, as they cover that part of the sea with a perpetual foam, and produce a hoarse and terrible roaring, very different from what the waves usually have in a deeper bottom. When a ship is driven among breakers, it is hardly possible to save her, as every billow that heaves upwards serves to dash her down with additional force, when it breaks over the rocks or sands beneath.

BREAKING, in a mercantile style, denotes the not paying one's bills of exchange accepted, or other promissory notes, when due; and absconding, to avoid the severity of one's creditors. In which sense, breaking is the same thing with becoming bankrupt. See Bankrupt.

Breaking *bulk*, in the sea language, is the same with unlading part of the cargo.

BREAMING, in maritime affairs, burning off the filth, such as grass, ooze, shells, or sea-weed, from the ship's bottom, which it has contracted by lying long in the harbour: it is performed by holding kindled furze, faggots, &c. which, by melting the pitch that formerly covered it, loosens whatever filth may have adhered to the planks. The bottom is then covered anew. This operation may be performed either by laying the ship aground, after the tide has ebbed from her, or by docking, or careening. See Careening.

BREAST, in anatomy, denotes the fore part of the thorax. See Anatomy.

Breasts, two glandulous tumours, of a roundish oval figure, situated on the anterior, and a little towards the lateral parts of the thorax. See Anatomy.

Breast *work*, in military affairs, is an elevation thrown up around a fortified place, to conceal or protect the garrison, and which is at the same time so strong, that the enemies' shot cannot pierce it. The terms breast work and parapet are frequently used without any distinction, but the former is more applicable in a general sense; a parapet implying more immediately that breast work which is raised upon the rampart of a fortified town.

BRECCIA, a term employed by Italian statuaries, to denote those kinds of marble which are really or apparently composed of angular fragments of marble, cemented together by a posterior infiltration of calcareous spar or marble. The French have adopted the term, and extended its meaning so as to include any strong mass composed of angular fragments consolidated by a cement. Hence they subdivide the term breche in calcareous, magnesian, siliceous, and argillaceous, taking care to discriminate it from amygdaloid or pondingere, (from the English pudding-stone) by restricting the meaning of this latter to stony masses, formed of rounded pebbles, imbedded in a cement.

BREDEMEYERA, in botany, a genus of the Diadelphia Octandria: calyx three-leaved; corolla papilionaceous; banner two-leaved; drupe with a two-celled nut. One species, *viz*. B. floribunda.

BREECH, of a gun, the distance from the hind part of the base ring to the beginning of the bore, and is always equal to the thickness of the metal at the vent.

BREECHINGS, in the sea language, the ropes with which the great guns are lashed or fastened to the ship's side. They are thus called, because made to pass round the breech of the gun.

BREEZE, a shifting wind, that blows from sea or land for some certain hours of the day or night; common in Africa, and some parts of the East and West Indies. The sea breeze is only sensible near the coasts; it commonly rises in the morning about nine, proceeding slowly, in a fine small black curl on the water, towards the shore; it increases gradually till twelve, and dies about five. Upon its ceasing, the land breeze commences, which increases till twelve at night, and is succeeded in the morning by the sea breeze again.

Breeze, in brick-making, small ashes and cinders, sometimes made use of instead of coals, for the burning of bricks.

BRENTUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ moniliform, inserted beyond the middle of the snout; head projecting into a very long, straight, cylindrical snout. There are eleven species, in two divisions; A. thighs simple; B. thighs toothed. B. bispar is linear and black; shells striate, with two obsolete rufous spots, and an abbreviated line at the base of each: thorax ovate, with an obsolete rufous band. In one sex the snout is cylindrical, black; in the other sex the snout is projected, cylindrical, dilated at the tip, with incurved jaws.

BREVE, in music, a note or character of time, in the form of a diamond or square, without any tail, and equivalent to two measures, or minims.

Breve, or Brevis, in grammar: syllables are distinguished into longs and breves, according as they are pronounced quicker or more slow.

BREVET *rank*, is a rank in the army higher than that for which a person receives pay. It gives precedence when corps are brigaded, according to the date of the brevet commission.

BREVIARY, a daily office, or book of divine service in the Romish Church. It is composed of matins, lauds, first, third, sixth, and ninth vespers, and the compline or post communio.

The breviary of Rome is general, and may be used in all places; but on the model of this, various others have been built, appropriated to each diocese, and each order of religious.

BREWER, a person who professes the art of brewing. There are companies of brewers in most capital cities; that of London was incorporated in 1427, by Henry VI. and that of Paris is still older.

BREWING, the art of brewing, or of preparing a vinous fermented liquor from the farinaceous seeds, is of very high antiquity. The ancient Egyptians, from the soil and climate of their country not being favourable to the culture of the vine, were induced to seek a substitute in barley, from which, in all probability, by the process of malting, they knew how to procure a fermented liquor. All the ancient malt liquors, however, seem to have been made entirely of barley, or some other farinaceous grain, and therefore were not generally calculated for long keeping, as this quality depends considerably, though not entirely, on the bitter extract of hops, or other vegetables, with which the liquor is mingled. Modern malt liquor is essentially composed of water, of the soluble parts of malt and hops, and of yeast.

Three or four different kinds of malt are distinguished by the brewer by their colours, which depend on the degree of heat that is used in the drying. Malt that has been dried by a very gentle heat scarcely differs in its colour from barley; if exposed to a somewhat higher temperature, it acquires a light amber-yellow hue; and by successive increments of heat, the colour becomes deeper and deeper, till, at length, it is black. The change of colour is owing to the grain being partially charred or decomposed; and in proportion to the extent to which this alteration is allowed to proceed will the produce of sugar, that is, of fermentable matter, be diminished. The principal advantage of high-dried malt over the paler kind is, the deep yellowish-brown tinge which it gives to the liquor; but this colour may be communicated much more economically by burnt sugar. The malt, whether pale or high dried, must be bruised between rollers, or coarsely ground in a mill before it is used; and it is found by experience, that malt which has lain to cool for some weeks is, in many respects, preferable to that which is used as it comes hot from the mill. The first step in the process of brewing is

Mashing. This is performed in the mash-tun, which is a circular wooden vessel, shallow in proportion to its extent, and furnished with a false bottom, pierced with small holes, fixed a few inches above the real bottom: when it is small, it ought to have a moveable wooden cover. There are two side openings in the interval between the real and false bottoms; to one is fixed a pipe, for the purpose of conveying water into the tun: the other is fitted with a spigot, for the purpose of drawing the liquor out of the tun. The brewing commences by strewing the grist or bruised malt evenly over the false bottom of the mash-tun, and then, by means of the side pipe, letting in from the upper copper the proper quantity of hot water. The water first fills the interval between the two bottoms, then, forcing its way through the holes in the false bottom, it soaks into the grist, which, at first floating on the surface of the water, is thus raised off the bottom on which it was spread. When the whole of the water is let in, the process of mashing, properly so called, begins. The object in mashing is, to effect a perfect mixture of the malt with the water, in order that all the soluble parts may be extracted by this fluid: for this purpose, the grist is first incorporated with the water by means of iron rakes, and then the mass is beaten and agitated, and still further mixed by long flat wooden poles, resembling oars, which indeed is the name by which they are technically known. In some of the large porter breweries, the extent of the tun is so great, that the process of mashing cannot be adequately performed by human labour, and recourse is had to a very simple and effectual instrument for this purpose. A very strong iron screw, of the same height as the mash-tun, is fixed in the centre of this vessel, from which proceed two great arms or radii, also of iron, and beset with vertical iron teeth a few inches asunder, in the manner of a double comb; by means of a steam engine, or any other moving power, the iron arms, which at first rest on the false bottom, are made slowly to revolve upon the central screw, in consequence of which, in proportion as they revolve, they also ascend through the contents of the tun to the surface: then, inverting the circular motion, they descend again in the course of a few revolutions to the bottom. These alternate motions are continued till the grist and water are thoroughly incorporated. When the mashing is completed, the tun is covered in to prevent the escape of the heat, and the whole is suffered to remain still, in order that the insoluble parts may separate from the liquor: the side spigot is then withdrawn, and the clear wort is allowed to run off, slowly at first, but more rapidly as it becomes fine, into the lower or boiling copper. The principal thing to be attended to is the temperature of the mash, which depends, partly on the heat of the water, and partly on the state of the malt. If any quantity of barley is mingled with twice its bulk of water, the temperature of the mass will be very nearly that of the mean temperature of the ingredients. If the palest malt is subjected to the same experiment, the temperature will be somewhat greater than that of the mean heat. The most eligible temperature upon the whole for mashing appears to be about 185° to 190° of Fahrenheit: the heat of the water, therefore, for the first mashing must be somewhat below this temperature, and the lower in proportion to the dark colour of the malt made use of. Thus, for pale malt, the water of the mash may be at 180° and upwards; but for high-dried brown malt, it ought not much to exceed 170°.

The wort of the first mashing is always by much the richest in saccharine matter; but to exhaust the malt, a second and third mashing is required; and as no heat is generated except in the first mashing, the water in the succeeding ones may be safely raised to nearly 190°. The proportion of wort to be obtained from each bushel of malt depends entirely on the proposed strength of the liquor. For sound small beer, thirty gallons of wort may be taken from each bushel of malt; but for the strongest ale, only the produce of the first mashing, or about six and a half gallons per bushel, is employed. But whatever be the proportion of wort required, it must be held in mind, that every bushel of well made malt will absorb and retain three and three quarters gallons of water, and, therefore, the water made use of must exceed the wort required in the same proportion.

Boiling and hopping. If only one kind of liquor (whether ale or beer) is to be made, the produce of the three mashings is to be mixed together; but if both ale and beer are required, the wort of the first, or of the first and second mashings, is appropriated to the ale, and the remainder is set aside for the beer. All the wort destined for the same liquor, after it has run from the mash-tun, is transferred to the large lower copper, and mixed while it is heating with the required proportion of hops. The stronger the wort is, the larger proportion of hops does it demand: and this is calculated in two ways, either according to the quantity of malt employed, or the richness of the wort. Where the former basis of calculation is referred to, the quantity of hops, especially in private families, where economy is not so strictly attended to as in large establishments, is one pound of hops to a bushel of malt, whether the wort is intended for the strongest ale or the weakest small beer. In public breweries, the proportion of hops is considerably smaller, and is regulated, not merely by the quantity of malt, but the richness of the wort. For strong ales, the common proportion is about one pound of hops to 1.3 bushel of malt; for beer, the quantity is lowered to one pound of hops to 1.7 bushel of malt. When both ale and beer are brewed from the same malt, the usual practice is, to put the whole quantity of hops in the ale wort; and after they have been boiled a sufficient time in this, to transfer them to the beer wort, in order to be exhausted by a second boiling. When the hops are mixed with the wort in the copper, the liquor is brought to boil; and the best practice is, to keep it boiling as fast as possible, till, upon taking a little of the liquor out, it is found to be full of minute flakes, like curdled soap. These flakes consist of the gluten and starch of the malt separated from their former solution in the wort, by the joint action, in all probability, of the heat, and the bitter extract of the hops.

Cooling. When the liquor is sufficiently boiled, it is discharged into a number of shallow tubs, called coolers, where it remains exposed to a free draft of air, till it has deposited the hop seeds and coagulated flakes with which it was charged, and is become sufficiently cool to be submitted to the next process, which is that of fermentation. It is necessary that the process of cooling should be carried on as expeditiously as possible, particularly in hot weather; for unfermented wort, by exposure to a hot close air for a few hours, is very liable to contract a nauseous smell and taste, when it is said technically to be foxed, in consequence of small spots of white mould forming on its surface. Liquor made from pale malt, and which is intended for immediate drinking, need not be cooled lower than 75° or 80°, and, in consequence, may be made all the year through, except, perhaps, during the very hottest season; but beer from brown malt, especially if intended for long keeping, requires to be cooled to 65° or 70°, and therefore cannot possibly be made, except in cool weather; hence it is, that the months of March and October have always been reckoned peculiarly favourable to the manufacture of the best malt liquor.

Tunning and barrelling. From the coolers the liquor is transferred into the fermenting or working tun, which is a large cubical wooden vessel, capable of being closed at pleasure. As soon as the wort is let in, it is well mixed with yeast, in the proportion of about one gallon to four barrels, and in about five hours afterwards the fermentation commences. When the wort is let down hot into the working tun, the fermentation is conducted with the tun closed, and proceeds rapidly, so that in about eighteen or twenty hours it is fit to be cleansed or put into the barrels: but when the wort is let down at 65°, it requires forty-eight hours for the first fermentation, and is peculiarly liable to be affected by a considerable change of weather.

The last process is, transferring the liquor from the working tun to the barrels, when the fermentation is completed. During a few days, a copious discharge of yeast takes place from the bung-hole, and the barrels must be carefully filled up every day with fresh liquor: this discharge gradually becomes less, and in about a week ceases; at which time the bung-hole is closed up, and the liquor is fit for use, after standing from a fortnight to three months, according to its strength, and the temperature at which it has been fermented.

BREYNIA, in botany, so named in memory of Jacob Breynius and his son, both famous botanists, a genus of the Polygamia Dioecia class and order. Essential character: calyx one-leafed; corolla none: Herm. calyx six-parted; anthers five, linear, fastened to the style; berry, three celled; seeds two. Male, calyx five parted; filaments five; anthers roundish. Female, stigmas five, obcordate, petalloid, without any style: capsule five-celled; seed solitary. There is but one species, *viz.* B. disticha, a native of New Caledonia, and the Isle of Tanna in the South Seas.

BRIBERY, in common law, is when a person, occupying a judicial place, takes any fee, gift, reward, or brocage, for doing his office, or by colour of his office, except of the king only. In a larger sense, bribery denotes the receiving or offering of any undue reward, to or by any person concerned in the administration of public justice, as an inducement for acting contrary to duty; and sometimes it signifies the taking or giving of a reward for a public office. In England, this offence of taking bribes is punished, in inferior officers, with fine and imprisonment; and in those who offer a bribe, though not taken, the same. But in judges, especially the superior ones, it has always been regarded as a very heinous offence; insomuch, that anciently it was punished as high treason, and the chief justice Thorp was hanged for it in the reign of Edward III. and at this day it is punishable with forfeiture of office, fine, and imprisonment. Officers of the customs taking any bribe, whereby the crown may be defrauded, forfeit 100*l.* and are rendered incapable of any office; and the person giving the bribe, or offering any bribe to officers of the customs, to induce them to connive at the running of goods, shall forfeit 50*l.* Candidates that bribe electors, after the date or teste of the writs, or after the vacancy, by giving or promising any money, or entertainment, are disabled to serve for that place in parliament; and he that takes, as well as he that offers, a bribe, forfeits 500*l.* and is for ever disabled from voting, and holding any office in any corporation, unless before conviction, he discovers some other offender of the same kind, whereby he is indemnified for his own offence.

BRICK, a well known substance, four inches broad, and eight or nine long, made by means of a wooden mould, and then baked or burnt in a kiln, to serve the purposes of building.

Bricks are of great antiquity, as appears by the sacred writings, the tower and walls of Babylon being built with them. In the east they baked their bricks in the sun; the Romans used them unburnt, only leaving them to dry for four or five years in the air. The general process of the manufacture of bricks here is as follows: the earth should be dug in the autumn; it should lie during the whole of the winter exposed to the frost, as the action of the air, in penetrating and dividing the particles of the earth, facilitates the subsequent operations of mixing and tempering. During this time the earth should be repeatedly turned and worked with the spade. In the spring, the clay is broken in pieces and thrown into shallow pits, where it is watered, and suffered to remain soaking for several days. The next step is, that of tempering the clay, which is generally performed by the treading of men or oxen. In the neighbourhood of London, however, this operation is performed by means of a horse-mill. The tempering of the clay is the most laborious part of the process, and that on which the perfection of the manufacture essentially depends. It is to neglect in this part that we are chiefly to attribute the bad quality of modern bricks, in comparison with the ancient. All the stones should be removed, and the clay brought to a perfectly homogeneous paste, using the least possible quantity of water. The earth, being sufficiently prepared in the pits, is brought to the bench of the moulder, who works the clay into the brick-moulds, and strikes off the superfluous earth. The bricks are delivered from the mould, and ranged on the ground; and when they have acquired a sufficient hardness to admit of handling, they are dressed with a knife, and stacked or built up in long dwarf walls, and thatched over where they remain to dry.

The method of burning bricks. Bricks are burnt either in a kiln or clamp. Those that are burnt in a kiln are first set or placed in it, and then the kiln being covered with pieces of bricks, they put in some wood, to dry them with a gentle fire; and this they continue till the bricks are pretty dry, which is very easily known by those accustomed to the business: they then leave off putting in wood, and proceed to make ready for burning, which is performed by putting in brush, furze, spray, heath, brake, or fern faggots, but before they put in any faggots, they dam up the mouth or mouths of the kiln with pieces of bricks, piled up one upon another, and close it up with wet brick-earth, instead of mortar; then they proceed to put in more faggots, till the kiln and its arches look white, and the fire appears at the top of the kiln; upon which they slacken the fire for an hour, and let all cool by degrees. This they continue to do, alternately heating and slacking, till the ware be thoroughly burnt, which is usually effected in forty-eight hours.

About London, they chiefly burn in clamps, built of the bricks themselves, after the manner of arches in kilns, with a vacancy between each brick, for the fire to play through; but with this difference, that instead of arching, they span it over, by making the bricks project one over another, and on both sides of the place, for the wood and coals to lie in till they meet, and are bounded by the bricks at the top, which close all up. The place for the fuel is carried up straight on both sides till about 3 feet high; when they almost fill it with wood, and over that lay a covering of sea-coal, and then overspan the arch; but they strew sea-coal also over the clamp, betwixt all the rows of bricks; lastly, they kindle the wood, which gives fire to the coal, and when all is burnt, then they conclude the bricks are sufficiently burnt.

The different kinds of bricks made in this country are principally place bricks, grey and red stocks, marl facing bricks, and cutting bricks. The place bricks and stocks are used in common walling; the marls are made in the neighbourhood of London, and used in the outside of buildings; these are very beautiful bricks, of a fine yellow colour, hard and well burnt, and in every respect superior to the stocks. The finest kind of marl and red bricks are called cutting bricks, they are used in the arches over windows and doors, being rubbed to a centre and guaged to a height. There is also a fine kind of white bricks made near Ipswich, which are used for facing, and sometimes brought to London for that purpose. The Windsor bricks, or fire bricks, which are made at Hedgerly, a village near Windsor, are red bricks, containing a very large proportion of sand; these are used for coating furnaces and lining the ovens of glass houses, where they stand the utmost fury of the fire. Dutch clinkers are also imported, long narrow bricks, of a brimstone colour, very hard and well burnt; they are frequently warped, and appear almost vitrified by the heat.

BRICKLAYER, one who lays bricks in the building of edifices of any kind. Tilers and bricklayers were incorporated, 10 Elizabeth, under the name of master and wardens of the society of freedom of the mystery and art of tilers and bricklayers. The materials used by bricklayers are, bricks, tiles, mortar, laths, nails, and tile-pins. Their tools are, a brick-trowel, wherewith to take up mortar; a brick-axe, to cut bricks to the determined shape; a saw, for sawing bricks; a rub-stone, on which to rub them; also a square, wherewith to lay the bed or bottom, and face or surface of the brick, to see whether they be at right angles; a bevel, by which to cut the under sizes of bricks to the angles required; a small trannel of iron, wherewith to mark the bricks; a float-stone, with which to rub a moulding of brick to the pattern described; a banker, to cut the bricks on; line-pins, to lay their rows or courses by; plumb-rule, whereby to carry their work upright; level, to conduct it horizontal; square, to set off right angles; ten foot rod, with which to take dimensions; jointer, wherewith to run the long joints; rammer, with which to beat the foundation; crow and pick-axe, wherewith to dig through walls.

BRIDEWELL, in Bridge-street, Blackfriars, a singular foundation, comprising within the same walls, an hospital, a work-house, and a prison. Edward VI. founded this place, which had formerly been one of King John's palaces. Several manufacturers reside there, who have the privilege of taking apprentices. When these have served faithfully the period of their servitude, they have a title to the freedom of the city, and ten pounds to assist them in the world.

BRIDGE, a work of masonry or timber, consisting of one or more arches, built over a river, canal, or the like, for the convenience of crossing the same. Bridges are a sort of edifices very difficult to execute, on account of the inconvenience of laying foundations and walling under water.

The parts of a bridge are, the piers, the arches, the pavement, or way over for cattle and carriages, the foot way on each side for foot passengers, the rail or parapet which incloses the whole, and the butments or ends of the bridge on the bank.

The conditions required in a bridge are, that it be well designed, commodious, durable, and suitably decorated. The piers of stone bridges should be equal in number, that there may be one arch in the middle, where commonly the current is strongest; their thickness is not to be less than a sixth part of the span of the arch, nor more than a fourth; they are commonly guarded in the front with angular sterlings, to break the force of the current: the strongest arches are those whose sweep is a whole semicircle; as the piers of bridges always diminish the bed of a river, in case of inundations, the bed must be sunk or hollowed in proportion to the space taken up by the piers.

(as the waters gain in depth what they lose in breadth,) otherwise the current may wash away the foundation, and endanger the piers: to prevent this, they sometimes diminish the current, either by lengthening its course, or by making it more winding; or by stopping the bottom with rows of planks, stakes or piles, which break the current. It is also required, that the foundation of bridges be laid at that season of the year when the waters are lowest: and if the ground be rocky, hard gravel, or stony, the first stones of the foundation may be laid on the surface; but if the soil be soft sand, it will be necessary to dig till you come to a firm bottom. For the particular mode of constructing stone bridges, the reader is referred to the latter end of the article BUILDING.

The triangular bridge at Croyland, in Lincolnshire, England, which was erected about the year 860, is said to be the most ancient Gothic structure remaining entire in the kingdom. There are two circumstances in the construction of this bridge which render it an object of great curiosity. First, it is formed by three semi-arches, whose bases stand in the circumference of a circle, at equal distances from each other. These unite at the top; and the triune nature of the structure has led some to imagine that it was intended as an emblem of the Trinity. Secondly, the ascent on each of the semi-arches is by steps paved with small stones set edgeways, and is so steep, that none but foot passengers can go over the bridge: horsemen and carriages frequently pass under it, as the river in that place is but shallow. For what purpose this bridge was really designed, it is difficult, if not impossible, to determine. Utility, it is obvious, was one of the least motives to its erection. To boldness of design and singularity of construction it has more powerful claims; and these qualities it must be allowed to possess, in as great a degree as any bridge in Europe. Although this bridge has been erected so many centuries, it exhibits no marks of decay.

London bridge is in the old Gothic style, and had twenty small locks or arches; but there are now only nineteen open, two having been lately thrown into one in the centre. It is 940 feet long, 44 high, and 47 clear width between the parapets. The piers are from 15 to 35 feet thick, with sterlings projecting at each side and end, so that the greatest water-way, when the tide is above the sterlings, is 545 feet, scarcely half the breadth of the river; and below the sterlings the water-way is reduced to 204 feet, causing a dangerous fall at low water. London bridge was first built with timber in the reign of Ethelred, between the years 993 and 1016; it was repaired, or rather rebuilt, of timber in 1163; and the present stone bridge was begun under King Henry II. in 1176, and finished under King John in the year 1209. It is probable there were no houses on the bridge for upwards of 200 years, since we read of a tilt and tournament held on it in 1395. Houses were erected upon it afterwards, but being found a great inconvenience and nuisance, they were removed in 1758, the avenues to the bridge enlarged, and the whole made more commodious: the two middle arches were then thrown into one, by removing the pier from between them. The expense of the repairs amounted to above 80,000*l.*

The bridges of Westminster and Blackfriars, over the river Thames at London, are among the finest structures of the kind in Europe. The former is 1220 feet long, and 44 feet wide, having a commodious broad foot-path on each side for passengers. It consists of thirteen large and two small arches, fourteen intermediate piers, and two abutments. The length of each abutment is 76 feet; the opening of each of the smaller arches is 25 feet; the span of the first of the large arches at each end is 52 feet, of the next 56 feet, and so on, increasing by four feet at a time to the centre arch, the span of which is 76 feet. The two piers of the middle arch are 17 feet wide; and the others decrease equally on each side, by one foot at a time, every pier terminating with a salient right angle against either stream. The arches are semi-circular, and spring from about the height of two feet above low water. The breadth of the river in this place is about 1220 feet, and the water-way through the bridge amounts to 870 feet. The bridge was begun in 1738, and opened for passengers in 1750, at a neat expense of 218,800*l.* It is constructed of the best materials, and in a neat and elegant taste; but the arches are too small in proportion to the quantity of masonry.

Blackfriars bridge, nearly opposite to the centre of the city of London, was begun in 1760, and completed in ten years and three quarters, at a neat expense of 152,840*l.* It is an exceedingly light and elegant structure; but, unfortunately, the materials do not seem to be of the best kind, as many of the stones in the piers are decayed. The bridge consists of nine large, handsome, and nearly elliptical arches; the centre arch is 100 feet wide, and the four arches on each side, reckoning towards the shores, decrease gradually, being 98, 93, 83, and 70 feet, respectively, leaving a water-way of 788 feet. The whole length from wharf to wharf is 995 feet, the breadth of the carriage-way 28 feet, and that of the raised foot-way on each side 7 feet. The upper surface of the bridge is a portion of a very large circle, which forms an elegant figure, and admits of convenient passage over it. On each pier there is a recess or balcony, with two Ionic columns and pilastres, which stand on a circular projection of the pier above high-water mark. The bridge is rounded off at each extremity to the right and left, in the form of a quadrant of a circle, rendering the access commodious and agreeable. This edifice must be regarded as a fine specimen of Mr. Milne's ingenuity and judgment, though the method of construction has never been made public.

Wooden bridges now demand our attention. The simplest case of these edifices is that in which the road-way is laid over beams placed horizontally, and supported at each end by piers or posts. This method, however, is deficient in strength and width of opening; it is, therefore, necessary, in all works of any magnitude, to apply the principles of trussing, as used in roofs and arches. Wooden bridges of this kind are stiff frames of carpentry, in which, by a proper disposition, beams are put so as to stand in place of solid bodies, as large as the spaces which the beams inclose; and thus two or three, or more, of these are set in a butment with each other, like mighty arch stones. At Schaffhausen, in Switzerland, where the Rhine flows with great rapidity, several stone bridges had been destroyed, when, in 1754, Grubenhamm offered to throw a wooden bridge of a single arch across the river, which is nearly 390 feet wide. The magistrates, however, required that it should consist of two arches, and that he should, for that purpose, employ the middle pier of the last stone bridge, which would divide the new one into two unequal arches of 172 and 193 feet span. The carpenter did so; but contrived to leave it a matter of doubt, whether the bridge is at all supported by the middle pier. It was erected on a plan nearly similar to the Wittengen bridge, at the expense of about 8,000*l.* sterling. Travellers inform us, that it shook if a man passed over it; yet waggons, heavily laden, also went over it without danger. This curious bridge was burnt by the French when they evacuated Schaffhausen, in April, 1799.

Iron bridges are the exclusive invention of British artists. The first that has been erected on a large scale is that over the river Severn, at Coalbrook Dale, in Shropshire. This bridge is composed of five ribs, and each rib of three concentric arcs, connected together by radiating pieces. The interior arc forms a complete semi-circle, but the others extend only to the cills under the road-way. These arcs pass through an upright frame of iron, at each end, which serves as a guide; and the small space in the haunches between the frames and the outer arc is filled in with a ring of about seven feet diameter. Upon the top of the ribs are laid cast iron plates, which sustain the road-way. The arch of this bridge is 100 feet 6 inches in span; the interior ring is cast in two pieces, each piece being about 70 feet in length. It was constructed in the year 1779, by Mr. Abraham Darby, iron-master at Coalbrook Dale, and must be considered as a very bold effort in the first instance of adopting a new material. The total weight of the metal is 378½ tons.

The second iron bridge, of which the particulars have come to our knowledge, was that designed by Mr. Thomas Paine, author of many political works. It was constructed by Messrs. Walkers, at Rotherham, and was brought to London, and set up in a bowling green at Paddington, where it was exhibited for some time. After which it was intended to have been sent to America; but Mr. Paine not being able to defray the expense, the manufacturers took it back, and the malleable iron was afterwards worked up in the construction of the bridge at Wearmouth.

The third iron bridge of importance erected in Great Britain was that over the river Wear, at Bishop Wearmouth, near Sunderland, the chief projector of which was Rowland Burdon, Esq. M. P. This bridge consists of a single arch, whose span is 236 feet; and as the springing stones at each side project two feet, the whole opening is 240 feet. The arch is a segment of a circle, of about 444 feet diameter, its versed sine is 34 feet, and the whole height from low water about 100 feet, admitting vessels of from two to three hundred tons burden to pass under, without striking their masts. A series of one hundred and five blocks form a rib, and six of these ribs compose the breadth of the bridge. The spandrils, or the spaces between the arch and the road-way, are filled up by cast iron circles, which touch the outer circumference of the arch, and at the same time support the road-way, thus gradually diminishing from the abutments towards the centre of the bridge. There are also diagonal iron bars, which are laid on the tops of the ribs, and extended to the abutments, to keep the ribs from twisting. The superstructure is a strong frame of timber, planked over, to support the carriage-road, which is composed of marl, lime-stone, and gravel, with a cement of tar and chalk immediately upon the planks to preserve them. The whole width of the bridge is 32 feet. The abutments are masses of almost solid masonry, 24 feet in thickness, 42 in breadth at bottom, and 37 at top. The south pier is founded on the solid rock, and rises from about 22 feet above the bed of the river. On the north side the ground was not so favourable, so that it was necessary to carry the foundation 10 feet below the bed. The weight of the iron in this extraordinary fabric amounts to 260 tons; 46 of these are malleable, and 214 cast. The entire expense was 27,000*l.*

The splendid example of the bridge at Wearmouth gave an impulse to public taste, and caused an emulation among artists, which has produced many examples, and more projects of iron bridges. The Coalbrook Dale Company have constructed several, among which is a very neat one over the river Parrot, at Bridgewater. Mr. Wilson, the engineer employed by Mr. Burdon, has also built several, and some years since finished a very elegant one over the river Thames, at Staines, which is by far the most complete in design, as well as the best executed, of any that has hitherto been erected. This bridge consists of a single arch, 181 feet in span, and 16 feet 6 inches in rise, being a segment of a circle of 480 feet. The blocks of which the ribs are composed are similar to those in the Wearmouth bridge, except that these have only two concentric arcs instead of three, as at the latter. The arcs are cast hollow, and the block connected by means of dowels and keys; thus obviating the great defect observed at Wearmouth, of having so much hammered iron exposed to the action of the air. Four ribs form the width of the arch, which are connected together by cross frames. The spandrels are filled in with circles, which support a covering of iron plates an inch thick: on this is laid the roadway, 27 feet wide. Two hundred and seventy tons is the weight of the iron employed in the bridge, and three hundred and thirty of the road-way.

Public bridges, which are of general conveniency, are of common right to be repaired by the inhabitants of that county in which they lie. Where a man makes a bridge for the common good of the King's subjects, he is not bound to repair it. No one can be compelled to build, or contribute to the charges of building any new bridge, without act of parliament: and if none are bounden to repair by tenure of prescription at common law, then the whole county or franchise shall repair it.

Bridges, *pendent or hanging*, called also philosophical bridges, are those not supported by posts or pillars, but hung at large in the air, sustained only at the two ends or abutments.

Bridge, *draw*, one that is fastened with hinges at the one end only, so that the other may be drawn up; in which case the bridge stands upright, to hinder the passage of a ditch or moat.

Bridge, *flying or floating*, is generally made of two small bridges, laid one over the other in such a manner, that the uppermost stretches and runs out, by help of certain cords, running through pullies placed along the sides of the under bridge, which push it forwards, till the end of it joins the place it is intended to be fixed on.

Bridge *of boats*, boats made of copper, and joined side by side, till they reach across a river, which being covered with planks, are fastened with stakes or anchors.

Bridge *of communication*, is that made over a river, by which two armies, or forts, which are separated by that river, have a free communication with one another.

Bridge, *floating*, a bridge made use of, in form of a work in fortification, called a redoubt, consisting of two boats, covered with planks, which are solidly framed, so as to bear either horse or cannon.

Bridge, in gunnery, the two pieces of timber which go between the two transoms of a gun carriage, on which the bed rests.

Bridge, in music, a term for that part of a stringed instrument over which the strings are stretched. The bridge of a violin is about one inch and a quarter high, and near an inch and a half long.

BRIEF, in common law, a writ, whereby a man is summoned or attached to answer any action. It is called brief, because it is couched in a few words, without any preamble. Brief is also used for a writing issued out of any of the king's courts of record at Westminster, whereby something is commanded to be done, in order to justice, or the execution of the king's command.

Brief is also taken for a letter patent, granting a licence to a subject to make collection for any public or private loss, as briefs for loss by fire, to be read by ministers in churches, &c. These briefs must be read in all churches and chapels, within two months after receipt thereof; and the sums thereby collected shall be paid over to the undertaker of briefs, within six months after the delivery of the briefs, under penalty of 20*l.*

Brief is likewise an abridgment of a client's case, wrote out for the instruction of counsel, on a trial at law.

Briefs, *apostolical*, letters which the pope dispatches to princes, or other magistrates, relating to any public affair. These briefs are distinguished from bulls in this respect, the latter are more ample, and always written on parchment, and sealed with lead or green wax; whereas briefs are very concise, written on paper, sealed with red wax, and with the seal of the fisherman, or St. Peter in a boat.

BRIG. See **Brigantine.**

BRIGADE, in the military art, a party or division of a body of soldiers, whether horse or foot, under the command of a brigadier. An army is divided into brigades of horse and brigades of foot: a brigade of horse is a body of eight or ten squadrons; a brigade of foot consists of four, five, or six battalions. The eldest brigade has the right of the first line, and the second the right of the second, and the two next take the left of the two lines, and the youngest stand in the centre.

Brigade *major*, is an officer appointed by the brigadier, to assist him in the management and ordering of his brigade.

BRIGADIER, is the general officer who has the command of a brigade. The eldest colonels are generally advanced to this post. He that is upon duty is brigadier of the day. They march at the head of their own brigades, and are allowed a serjeant and ten men, of their own brigade, for their guard.

BRIGANTINE, a small light vessel, which can both row and sail well, and is either for fighting or giving chace. It has about twelve or fifteen benches for the rowers, one man to a bench: all the hands aboard are soldiers, and each man has his musket lying ready under his oar.

BRIGGS (Henry), in biography, a very considerable mathematician, born near Halifax, Yorkshire, in 1556; and in 1579, having attained a good share of grammatical knowledge, he went to St. John's College, Cambridge, where he took his degrees in regular order, and in 1588 was chosen fellow of his college. The bent of his mind was to the mathematics, in which he made so great and rapid a progress, that in 1592 he was appointed examiner and lecturer in that branch of science. In 1596 he was elected to the first professorship of geometry at Gresham College; he constructed a table for finding the latitude, from the variation of the magnetic needle being given. About the year 1609 he contracted an acquaintance with Mr. Usher, afterwards Archbishop of Armagh, and in correspondence with him he mentions his employment upon the calculation of eclipses, and soon after writes that he is wholly engaged about the noble invention of logarithms, which had just made their appearance, and in the improvement of which he afterwards had so great a concern. On this subject he delivered various lectures at Gresham College, and proposed to alter the scale from the hyperbolic form which Napier had given them, to that in which 1 should be the logarithm of the ratio of 10 to 1. In 1616 Briggs made a visit to Napier at Edinburgh, and communicated to him his wishes. The alteration was agreed upon, and in 1617 he published his first 1000 of logarithms. He succeeded in 1619 to the Savilian professorship of geometry at Oxford, upon which he resigned the duties of Gresham College. Here he devoted himself most sedulously to his studies, and published many works connected with the higher branches of mathematics. His "Arithmetica Logarithmica" was printed in 1624; it contained the logarithms of 30,000 natural numbers to 14 places of figures, besides the index. He completed a table of logarithmic sines and tangents for the 100th part of every degree to 14 places; with a table of natural sines, tangents, and secants, with the construction of the whole. These tables were printed, under the title of Trigonometria Britannica. "In the construction of these two works," says one of Mr. Brigg's biographers, "on the Logarithms of Numbers and of Sines and Tangents, our author, besides extreme labour and application, manifests the highest powers of genius and invention, as we here for the first time meet with several of the most important discoveries in the mathematics, and what have hitherto been considered as of much later invention; such as the Binomial Theorem; the Differential Method and Construction of Tables by Differences; the Interpolation of Differences, with Angular Sections, and several other ingenious compositions."

This great man died at Oxford in 1630, and was buried in the Chapel of Merten College, highly respected by his contemporaries, by many of whom his character was drawn with great ability: by Oughtred he is designated as the mirror of the age for his great skill in geometry: the learned Barrow extols his ability, skill, and industry, particularly in perfecting the invention of logarithms, which, without his care, might have continued an imperfect and useless design. Dr. Smith represents him as easy of access to all, free from arrogance, moroseness, envy, ambition, and avarice, a contemner of riches, and contented in his own situation; preferring a studious retirement to all the splendid circumstances of life.

BRIMSTONE. See Sulphur. Casts of medals have been taken off on a composition, of which the chief ingredient is sulphur, and hence they are called sulphur casts. By this means the most curious antiques may, to all useful purposes, be indefinitely multiplied. The composition is thus described: melt eight ounces of sulphur over a gentle fire, and with it mix an equal quantity of fine vermillion, stir it well together, and it will dissolve like oil, then cast it into the mould, which is first to be rubbed over with oil. When cool, the figure may be taken, and, touched over with aquafortis, it will look like fine coral.

BRIONIA, *alba*, a root used in medicine, which has been long known to contain a considerable portion of starch, and a bitter principle soluble in water and alcohol. It has lately been examined by the French chemists by maceration; the starch was separated and obtained in a state of purity. The bitter principle appeared to possess the properties in a very pure state. It was also found to contain a considerable portion of gum, which is precipitated by the infusion of galls, and which Vauquelin denominates vegeto-animal matter, some woody fibre, a small portion of sugar, and a quantity of supermalate of lime, and phosphate of lime.

BRISTLE, a rigid glossy kind of hair, found on swine, and much used by brush-makers, shoe-makers, saddlers, and others. They are chiefly imported from Russia and Poland. There is a heavy duty upon these.

BRITTLENESS, a quality of certain bodies, by which they are subjected to be easily broken by pressure or percussion. Brittle bodies are extremely hard; a very small percussion exerts a force on them equivalent to the greatest pressure, and thus they are easily broken. This effect is particularly remarkable in glass suddenly cooled, the brittleness of which thereby is much increased. In the new arrangement of Chemistry, the metals are distinguished into those that are more or less brittle, as one of their leading characteristics.

BRIZA, in botany, a genus of the Triandria Digynia. Natural order of Gramina or Grasses. Essential character: calyx bivalve, many-flowered; spikelet distinct, with heart-shaped obtuse valves, the lower of which is minute. There are six species: briza minor, small quaking grass, is an annual, according to Linnæus and Villars: by Hudson, and in the Kew Catalogue, it is marked as perennial. The culms are about a foot and a half in height; and the panicles are very much branched. Native of Germany, Switzerland, the South of France, Italy, and Britain. It flowers from June to August. B. media has a perennial root; culm upright, six or seven inches high in a dry soil, but in wet places it rises to two or three feet, having four or five knots on it. The panicle is handsome, spreads very much when in flower, and has two spikelets on each branch, placed on such long slender pedicles, as to shake with the least air or motion; each spikelet is composed of seven, eight, or nine florets, is heart-shaped, flatted, shining, smooth, varying in colours, usually variegated with green, white and purple. This beautiful grass is common in dry pastures in most parts of Europe. It flowers from May to July.

BROADSIDE, in the sea-language, denotes a volley of cannon, or a general discharge of all the guns on one side of a ship at once.

BROCADE, a stuff of gold, silver, or silk, raised and enriched with flowers, foliages, and other ornaments, according to the fancy of the merchants or manufacturers.

BROCCOLI, a kind of cabbage cultivated for the use of the table. See Brassica.

BROKER, a name given to persons of several and very different professions, the chief of which are exchange-brokers, stock-brokers, pawn-brokers, and brokers, simply so called, who sell household furniture and second-hand apparel.

Brokers, *exchange*, are a sort of negotiators who contrive, make, and conclude bargains between merchants and tradesmen, in matters of money or merchandize, for which they have a fee or premium. See Exchange.

Brokers, *insurance or policy*, are agents who transact the business of insurance, between the merchant or party insured and the underwriters or insurers. These insurance brokers, from the nature of their employment, ought to be, and indeed generally are, persons of respectability and honour, in whom unlimited confidence may be reposed. To the broker the merchant looks for the regularity of the contract, and a proper selection of responsible underwriters: and to him also the underwriters look for a fair and candid disclosure of all material circumstances affecting the risk, and for the payment of their premiums. There is usually an open account between each broker and every underwriter with whom he has much dealing. In this account the broker makes himself debtor to the underwriter for all premiums, and takes credit for all losses to which the underwriter is liable, and which the broker is authorised to receive. Indeed, it is generally understood, that by the usage of trade in London, the underwriters give credit only to the broker for their premiums, and can resort only to him for payment, and that he alone, and not the underwriters, can recover the premiums from the insured. This point, however, has never been settled by any judicial determination. But though the underwriter thus looks to the broker for his premium, and though the broker, in his account with the underwriter, takes credit for the losses and returns for premiums, which he is authorised to receive from the underwriter, yet such losses are not to be regarded as a debt from the underwriter to the broker. Where the merchant happens to reside at a distance from the place where he means to be insured, the policy is usually effected by the mediation of his agent or correspondent there, who, if he be not a broker, employs one, and gives him all necessary instructions. In order to his being an agent in such a case, he must either have express directions from the principal to cause the insurance to be made, or else it must be a duty arising from the nature of his correspondence with the principal. And no general authority which he may have, in relation to a ship or goods, will make him an agent for the purpose of insuring, on behalf of the parties interested. However, though one man cannot, in general, compel another against his consent to become an agent for procuring an insurance to be effected for him, there are three cases in which an order to insure must be complied with: as, first, where an agent has effects of his principal in his hands; secondly, where he has been in the practice of making insurances, and has given no notice to discontinue; and, thirdly, where he accepts bills of lading sent him on condition to insure. To the office of agent or broker, great responsibility attaches; and, in the execution of it, it is the duty of each to conduct himself with the greatest fidelity, punctuality, and circumspection. For in this, as in all other cases, where a man, either by an express or implied undertaking, engages to do an act for another, and he either wholly neglects to do it, or does it improperly or unskilfully, an action on the case will lie against him, to recover a satisfaction for the loss or damage resulting from his negligence or want of skill. Hence, if a merchant here accept an order from his correspondent abroad to cause an insurance to be made, but limits the broker to too small a premium, in consequence of which no insurance can be effected, he is liable to make good the loss to his correspondent; for though it is his duty to get the insurance done at as low a premium as possible, yet he has no right so to limit the premium, as to prevent the insurance from being effected. And even a voluntary agent, who has no prospect of remuneration for his trouble, is liable, provided that he takes any step in the business. It is not only the duty of the agent, in transacting the business of insurances, to conduct himself with fidelity and punctuality towards his employer, but he is also bound to observe the strictest veracity and candour towards the insurer: for any fraud or concealment on his part will make void the policy, even though the insured be altogether ignorant and innocent respecting it. In the action against an agent or broker, [illegible] ther for negligence or unski[illegible] effecting an insurance, the p[illegible] titled to recover to the same [illegible] he might have recovered against [illegible] derwriters, if the policy had [illegible] perly effected. But he can [illegible] what, in point of law, he mi[illegible] covered on the policy; and [illegible] indulgence or liberality of [illegible] writers might probably have [illegible] them to pay. In such an action, the agent may avail himself of every defence, such as fraud, deviation, non-compliance with warranties, &c. which the underwriters might have set up in an action on the policy: but if the agent act in the usual manner, it will be deemed sufficient. There are many reasons why an agent or broker ought not to be an insurer. He becomes too much interested to settle with fairness the rate of premium, the amount of partial losses, &c.; and though he should not himself occasion any unnecessary delay or obstacle to the payment of a loss, he will not be over anxious to remove the doubts of others: besides, he ought not, by underwriting the policy, to deprive the parties of his unbiassed testimony in case of dispute. If an agent or broker, meaning to appropriate the premium to himself, and take the chance of a safe arrival, represent to his employer, that an insurance has been effected agreeably to his instructions, the principal may maintain trover for the policy against the agent or broker; and, upon proof of a loss, he shall recover to the same amount as he would have been entitled to recover against the underwriters, if a policy had been effected.

Brokers, *stock*, are those employed to buy and sell shares in the joint stock of a company or corporation, and also in the public funds. The negociations, &c. of these brokers are regulated by several statutes, which, among other things, enact, that contracts in the nature of wages, &c. incur a penalty of 500*l.*; and by the sale of stock, of which the seller is not possessed, and which he does not transfer, a forfeit of 100*l.*; and contracts for sale of any stock, of which the contractors are not actually possessed, or to which they are not entitled, are void, and the parties agreeing to sell, &c. incur a penalty of 500*l.*; and that brokers keep a book, in which all contracts, with their dates, and the names of the parties concerned, shall be entered, on pain of 50*l.*: these enactments, however, are little regarded by the gamblers in the public funds.

Brokers, *pawn*, are persons who keep shops, and let out money to necessitous people upon pledges, for the most part on exorbitant interest. These are more properly called pawn-takers, or tallymen, sometimes fripers, or friperers. Of these is to be understood the statute of 1 Jac. I. c. 21, by which it is enacted, that the sale of goods, wrongfully gotten, to any broker in London, Westminster, Southwark, or within two miles of London, shall not alter the property thereof. If a broker, having received such goods, shall not, upon the request of the right owner, truly discover them, how and when he came by them, and to whom they are conveyed, he shall forfeit the double value thereof to the said owner. But there are several excellent regulations respecting pawn-brokers of later date.

BROKERAGE, the fee paid to a broker for his trouble in negociating business between person and person.

BROMELIA, in botany, so named in memory of Olaus Bromel, a Swede, a genus of the Hexandria Monogynia class and order. Natural order of Coronariæ. Bromeliæ, Jussieu. Essensial character: calyx trifid, superior; petals three, and a nectareous scale at the base of each; berry three-celled. There are nine species, one of which, B. ananas, or pine-apple, is a fruit now so well known in Europe, and so much esteemed for the richness of its flavour, is produced from an herbaceous plant which has leaves somewhat resembling those of aloe, and for the most part serrate on their edges, but much thinner and not so succulent as those of the aloe. The fruit resembles, in shape, the cone of some species of the pine-tree, from which it takes the vulgar name of pine-apple.

Where this plant is a native is difficult to determine, but it is probably an indigenous plant of Africa, where it grows in uncultivated places in great plenty. There are many varieties of this fruit, and if the seeds were sown frequently in their native country, the varieties would probably be as numerous as those of apples and pears in Europe. The queen pine is the most common, but the sugar loaf is much preferable, the fruit being larger and better flavoured; it is easily distinguished from the others by its leaves having purple stripes on their inside the whole length; it is also of a paler colour when ripe, inclining to straw colour. This was brought from Brazil to Jamaica, where it is esteemed far beyond the others. The smooth pine is preserved by some curious persons for the sake of variety, but the fruit is not worth eating. The green pine is at present the most rare in Europe; it has been esteemed the best sort known, by some of the most curious persons in America, many of whom have thrown out all the others to cultivate this only.

Those who wish to understand the propagation and culture of the pine-apple may consult Martyn's Botanical Dictionary with much advantage.

BROMUS, in botany, a genus of the Triandria Digynia class and order. Natural order of Gramina or Grasses. Essential character: calyx two-valved; spikelet oblong, columnar, distich; awn below the top. There are 25 species.

The several species of this genus of grasses are numerous, and have not yet been well distinguished. They have a loose panicle like the oat, hence they have been called the oat-grasses; the awn or beard proceeds from the back of the glume or chaff, or is an elongation of the keel or mid-rib, as in the genus Avena; but in that the awn is commonly twisted, whereas in this it is straight; modern writers, therefore, distinguish them by the name brome-grasses. The festuca is scarcely different from bromus as a natural genus; in that, however, the chaff is either very much pointed, or terminates in an awn; but that of bromus always comes to the tip. The genus triticum, or wheat, agrees with it in this respect: and, therefore, some have thought there is no mark of distinction between them; it is, however, distinct in the inflorescence or manner of flowering in a spike; whereas bromus, festuca, and avena, bear their flowers in a panicle.

BRONCHIA, in anatomy, the ramifications of the trachea. See ANATOMY.

BRONZE, in the arts, a compound metal, composed of from 8 to 12 parts of tin combined with 100 parts of copper. It is of a greyish yellow colour, harder than copper, less liable to rust, and more fusible, so as to run thin, and be easily cast in a mould. Hence its use in casting statues. The metal of which the artillery is cast is of a similar composition, containing rather less tin. An alloy similar to bronze was much in use among the ancients, as well for warlike weapons as for medals, coins, &c.

BROOM. See GENISTA.

BROSIMUM, in botany, a genus of the Dioecia Monandria class and order. Essential character: male, ament globular, covered all round with orbiculate, peltate scales; corolla none; filament solitary, between the scales: female, ament as in the male; corolla none; style bifid; berry one-seeded. There are but two species. B. alicastrum is a tree frequent in the island of Jamaica. It is computed to make up about a third part of the woods in the parishes of St. Elizabeth and St. James. The timber is not much esteemed; but the leaves and young branches are more useful, being fattening fodder for all sorts of cattle. The fruit, boiled with salt-fish, pork, beef, or pickle, is frequently the support of the negroes and poorer sort of white people in times of scarcity, and is a wholesome and not unpleasant food: when roasted, it eats something like our chesnuts, and is called bread-nut. B. spunium, is called milk-wood, and is common in St. Mary's parish, Jamaica. It rises to a considerable height in the woods, is reckoned among the timber trees, and is sometimes used as such, though not much valued.

BROSSÆA, in botany, so named from Guy de la Brosse, a genus of the Pentandria Monogynia class and order. Natural order of Bicornes. Ericæ, Jussieu. Essential character; calyx fleshy; corolla truncate; capsule five-celled, many seeded. There is but one species: *viz.* B. coccinea. An obscure plant, and the character doubtful, except what Plumier has said of it. In stature it is something like the codon. Branches alternate; leaves alternate, ovate, serrate, petiolate; flowers few, terminating the branches, alternate. It is a native of South America.

BROTERA, in botany, a genus of the Didynamia Gymnospermia. Calyx five-awned; middle segment of the lower lip of the corolla hooded, involving the stamina and style, and protruding them with a jerk. One species, B. persica, found in Persia.

BROWALLIA, in botany, given by Linnæus in honour of Job. Browallius, Bishop of Aboa, a genus of the Didynamia Angiospermia class and order. Natural order of Lunidæ. Scrophulariæ, Jussieu. Essential character: calyx five-toothed; corolla border five-cleft, equal, spreading, with the navel closed; anthers two larger; capsule one-celled. There are two species: B. demissa, spreading Browallia; and B. elata, upright Browallia. These are herbaceous annual plants, with alternate leaves. The flowers are either axillary or terminating. They have the habit of the solanaceous plants, and like them have the peduncle inserted either over against or at the side of the petioles. The former is a native of Panama, the latter of Peru. They both flower from July to September.

BROWNEA, in botany, from Dr. Patrick Browne, a genus of the Monadelphia Decandria. Natural order of Lomentaceæ. Leguminosæ, Jussieu. Essential character: calyx unequally bifid: corolla double; outer five-cleft; inner five-petalled: legume two-celled. There are two species: B. coccinea is a small tree, growing to the height of eighteen feet. When in flower it has a beautiful appearance. The flowers grow about ten together, and are pendulous. The calyx is ferruginous, the corolla scarlet, the stamens yellowish. This species grows in hilly and woody places in America. B. rosa is also an American shrub, or small tree, with an ash-coloured bark, opposite leaves, which are entire and smooth on both sides. The flowers are borne in a kind of aggregate manner, so as to form heads or bunches of the size of one's fist. They are red, and make a very beautiful appearance. The stamens are extremely long. It grows chiefly in hilly situations.

BROWNISTS, a sect of Christians, the name given for some time to those who were afterwards known in England and Holland under the denomination of Independents. It arose from a Mr. Robert Brown, whose parents resided in Rutlandshire, though he is said to have been born at Northampton; and who, from about 1571 to 1590, was a teacher amongst them in England, and at Middleburgh, in Zealand. He was a man of family, of zeal, of some abilities, and had a university education. The separation, however, does not appear to have originated in him; for, by several publications of those times, it is clear that these sentiments had, before his day, been embraced and professed in England, and churches gathered on the plan of them.

This denomination did not differ in point of doctrine from the church of England, or from the other Puritans; but they apprehended that, according to scripture, every church ought to be confined within the limits of a single congregation, and have the complete power of jurisdiction over its members, to be exercised by the elders within itself, without being subject to the authority of bishops, synods, presbyteries, or any ecclesiastical assembly, composed of the deputies from different churches. Under this name, though they always disowned it, were ranked the learned Henry Ainsworth, author of the "Annotations on the Pentateuch," &c.; the famous John Robinson, a part of whose congregation from Leyden, in Holland, made the first permanent settlement in North America; and the laborious Canne, the author of the "Marginal References to the Bible."

BRUCEA, in botany, in honour of James Bruce, Esq. the famous traveller, a genus of the Dioecia Tetandria class and order. Essential character: calyx four-parted; corolla four-petalled; female pericarpium four, one-seeded. There is but one species. B. ferruginea is a shrub of a middling size, with an upright stem; the bark is ash-coloured, branches few, alternate, round, patulous, and thick. Leaves alternate, spreading, unequally pinnate, consisting of six pairs of opposite lobes, one foot in length. Spikes of male flowers solitary; the flowers are crowded together, either sessile or on very short pedicles, of an herbaceous colour, tinged with red or russet. It is a native of Abyssinia, where it is known by the name of wooginoos. The root is a specific in the dysentery. It is a plain, simple bitter, without any aromatic or resinous taste, leaving in the throat and palate a disagreeable roughness.

BRUCHUS, in natural history, a genus of insects of the order Coleoptera. Generic character: antennæ filiform; feelers equal, filiform; lip pointed. Gmelin enumerates 27 species. This genus consists in general of small insects. The most remarkable is the B. pisi: shell black, spotted with white; tail with two black dots; thighs slightly toothed; is the usual inhabitant of the common pea. When the pea is boiled for the table, it contains this insect in the larva state.

BRUMALES, in botany, an epithet applied to plants which flower in our winter. These are common about the Cape.

BRUNFELSIA, in botany, so named in honour of Otho, or Otto Brunfelsus, a genus of the Didynamia Angiospermia. Natural order of Personatæ. Solaneæ, Jussieu. Essential character: five-toothed, narrow; corolla with a very long tube; capsule one-celled, many-seeded, with a very large fleshy conceptacle. There are two species, of which B. Americana is a tree, growing from ten to fifteen feet in height. The trunk is smooth and even, and the branches loose. Leaves alternate, entire, smooth, and shining; corolla yellow, very sweet scented, having a tube four or five inches in length. It grows naturally in Jamaica, and most of the sugar islands in the West Indies, whence they call it trumpet flower. B. undulata is also a native of Jamaica.

BRUNIA, in botany, a genus of the Pentandria Monogynia class and order. Natural order of Aggregatæ. Rhamni, Jussieu. Essential character: flowers aggregate; filaments inserted into the claws of the petals; stigma bifid; seeds solitary, two-celled. There are three species. B. lanaginosa, heath-leaved Brunia, resembles Levisanus abrotaroides, and has the nectareous chink, as in that. The stem is about a foot high, and shrubby. The leaves linear-filiform, smooth, short, with black tips. The flowers, which are white, are borne in heads. B. ciliata, ciliate-leaved brunia, has the germ superior and the style bifid. B. verticillata, whorled brunia, has small heads. They are all shrubs, and inhabitants of the Cape.

BRUNNICHIA, in botany, a genus of the Decandria Trigynia class and order. Calyx swelling, five-cleft; capsule three-sided, one-celled, many-seeded. One species, B. cirrhosa, a native of Bahama.

BRUSH, an instrument made of bristles, hair, wire, or small twigs, to clean clothes, rooms, &c. and also to paint with. There are various sorts of them, distinguished by their shape or use. In the choice of painters' brushes, observe whether the bristles are fast bound in the stocks, and if the hair be strong and lie close together; for if they sprawl abroad, such will never work well; and if they are not fast bound in the stock, the bristles will come out when you are using them, and spoil your work, as may be seen where the loose hairs of the brush have lain up and down in the colours laid on, to the great detriment of the work. Brushes, in which the hairs are fastened with silver wire, are very superior to those in which iron wire is used, especially where they are used in or with water. Brushes are used for medical purposes, in rheumatic affections of the joints, paralysis, &c. Mr. Thomason, of Birmingham, has a patent for hearth brushes, so constructed as to conceal the hair, by means of rack-work, in a metal case.

Brush, in electricity, denotes the luminous appearance of the electric matter issuing in a parcel of diverging rays from a point. Beccaria ascribes this appearance to the force with which the electric fluid, going out of a point, divides the contiguous air, and passes through it to that which is more remote.

BRUTA, in natural history, the second order of animals in the class Mammalia, the character of which consists in having no fore teeth in either jaw; feet with strong hoof-like nails; motion slow; food mostly masticated vegetables. There are nine genera of this order, enumerated by Gmelin, *viz.*

Bradypus
Dasypus
Elephas
Manis
Myrmecophaga
Platypus
Rhinoceros
Sukotyro
Trichechus.

BRUTE, or *beast*, a term generally applied to quadrupeds, and also to other animals, and implying inferiority of intellect.

Among brutes, the monkey kind, both in the external shape, and internal structure, bear the nearest resemblance to man. In the monkey kind, the highest, and the most nearly approaching the likeness of man, is the ourang-outang, or homo sylvestris. Philosophers are much divided about the essential characters of brutes. Some define brute as an animal not risible, or a living creature incapable of laughter; others, a mute animal, or a living thing destitute of speech; the Peripatetics, an animal endowed with a sensitive power, but without a rational one. The Platonists allow reason and understanding, as well as sense, to brutes, though in a degree less pure and refined than that of men. Indeed, the generality of the ancient philosophers thought that brutes reasoned: this, among the heathens, was the opinion of Anaxagoras, Porphyry, Celsus, Galen, Plutarch, as well as Plato and others.

That brutes possess reflection and sentiment, and are susceptible of the kind, as well as the irascible passions, independently of sexual attachment and natural affection, is evident from the numerous instances of affection and gratitude daily observable in different animals, particularly the dog.

Of these, and other sentiments, such as pride, and even a sense of glory, the elephant exhibits proofs equally surprising and unquestionable; for which we refer to the article Elephas.

The brute creation manifests also a wonderful spirit of sociality, independent of sexual attachment. It is well known that horses, which are perfectly quiet in company, cannot be kept by any fences in a field by themselves; oxen and cows will not fatten by themselves, but neglect the finest pasture that is not recommended by society: sheep constantly flock together. Nor is a propensity to associate restricted to animals of the same kind and size. Instances to this purpose are enumerated in "White's Natural History of Selborne," to which we refer the reader.

Mr. Locke maintains, that the souls of brutes are wholly material; that they do not possess the power of abstraction; and that the having of general ideas is that which puts a perfect distinction between men and brutes. Accordingly, he supposes that they have no use of words, or any general signs, by which to express their ideas. It has, however, been a subject of dispute, whether brute animals have any language intelligible to one another. Some have pretended, that they have a kind of jargon, by which they can make a mutual communication of their sentiments. There is at least a similitude of speech in brutes; for they know each other by their voices, and have their signs, whereby they express anger, joy, and other passions. Thus a dog assaults in one strain, fawns in another, howls in another, and cries when beaten in another.

Dr. Hartley has investigated the intellectual faculties of brutes, and applied his theory of vibrations and association in accounting for the inferiority of brutes to mankind, with regard to intellectual capacities. He ascribes the difference subsisting between them to the following circumstances, which he has taken occasion to illustrate on the principles of this theory. The first of these is the small proportionate size of their brains, whence brutes have a far less variety of ideas and intellectual affections than men. The second cause of this difference is the imperfection of the matter of their brains, whereby it is less fitted for retaining a large number of miniatures, and combining them by association, than man's. The third cause is their want of words, and such like symbols. Fourthly, the instinctive powers which they bring into the world with them, or which rise up from internal causes, as they advance towards adult age, is another cause of this difference; and, fifthly, it is partly owing to the difference between the external impressions made on the brute creation, and on mankind. This ingenious writer supposes, with Des Cartes, that all the motions of brutes are conducted by mere mechanism; yet he does not suppose them to be destitute of perception; but that they have this in a manner analagous to that which takes place in us; and that it is subjected to the same mechanical laws as the motions. He adds, that it ought always to be remembered, in speaking on this subject, that brutes have more reason than they can show, from their want of words, from our inattention, and from our ignorance of the import of those symbols, which they do use in giving intimations to one another, and to us.

BRYONIA, in botany, a genus of the Monoecia Syngenesia class and order. Natural order of Cucurbitæ. Essential character; calyx five-toothed; corolla five-parted: male, filaments three: female, style quadrifid. Berry subglobular, many-seeded. There are nineteen species, of which B. alba, black berried white bryony, seems to differ from the red in little else besides the colour of the berries. Native of Sweden, Denmark, Cariola, and probably other parts of Europe, in hedges. B. dioica, red berried white bryony, is easily distinguished by its prodigious root, its stems climbing by tendrils, leaves resembling those of the vine in shape, not smooth as they are, but harsh and rugged, and of a paler colour, and by its bunches of small berries, which are red when ripe, and produced on a different plant from the male flowers. B. palmata, palmated bryony, has heart-shaped leaves, the side divisions shortest; the upper surface is marked with dots, very close, but scarcely visible; there are callous tubercles of the veins and peduncles. The berries are round and large. It is a native of the Island of Ceylon.

BRYUM, in botany, a genus of moss, distinguished by a capsule covered with a lid, and over that a smooth veil. But these characters it has in common with Minium and Hypnum, two other genera much resembling this. The peculiar mark of the bryum is, that the thread or little stem supporting the fructification grows from a tubercle at the ends of the stem and branches.

BUBALUS, the *buffalo*, in zoology. See Bos.

BUBBLE, in philosophy, small drops or vesicles of any fluid filled with air, and either formed on its surface, by an addition of more of the fluid, as in raining, &c. or in its substance, by an intestine motion of its component particles.

Bubbles are dilatable or compressible, *i. e.* they take up more or less room, as the included air is more or less heated, or more or less pressed from without, and are round, because the included aura acts equally from within, all round; their coat is formed of minute particles of the fluid, retained either by the velocity of the air, or by the brisk attraction between those minute parts and the air.

The little bubbles rising up from fluids, or hanging on their surface, form the white scum at top, and these same bubbles form the steam or vapour flying from liquors in boiling.

Bubble, in commerce, a cant term, given to a kind of projects for raising of money on imaginary grounds, much practised in France and England, in the years 1719, 1720, and 1721.

The pretence of those schemes was, the raising a capital for retrieving, setting on foot, or carrying on some promising and useful branch of trade, manufacture, machinery, or the like : to this end proposals were made out, shewing the advantages to be derived from the undertaking, and inviting persons to be engaged in it. The sum necessary to manage the affair, together with the profits expected from it, were divided into shares or subscriptions, to be purchased by any disposed to adventure therein.

Bubbles, by which the public have been tricked, are of two kinds, *viz.* 1. Those which we may properly enough term trading bubbles; and, 2. Stock or fund-bubbles. The former have been of various kinds; and the latter at different times; the most remarkable one in this country was that in 1720.

BUBO, in ornithology, the name by which zoologists call the great horned owl, with a reddish-brown body. See Strix.

Bubo, in surgery, a tumour which arises, with inflammation, only in certain or particular parts to which they are proper, as in the arm-pits and in the groins.

BUBON, in botany, a genus of the Pentandria Digynia. Natural order of Umbellatæ. Essential character: fruit ovate, striated, villose. There are five species, of which B. macedonicum, Macedonian parsley, sends out many leaves from the root, the lower growing almost horizontally, spreading near the surface of the ground; the foot stalk of each leaf divides into several other smaller, garnished with smooth rhomb-shaped leaves, which are of a bright pale-green colour, indented on their edges. It is a native of Greece and Barbary. It flowers with us from June to August. In warm countries it is biennial, but in England the plants seldom flower till the third or fourth year from seed; but whenever they flower they always die. B. galbanum, lovage-leaved bubon, rises with an upright stalk to the height of eight or ten feet, having a purplish bark, covered with a whitish powder, which comes off when handled; the upper part of the stalk is covered with leaves at every joint, the foot stalks half embracing them at their base, branching out into several smaller, like those of the common parsley, and set with leaves like those of lovage, but smaller, and of a grey colour. It flowers in August, but has not produced seeds in England. When any part of the plant is broken, there issues out a little thin milk, of a cream colour, which has a strong scent of galbanum. It is a native of the Cape of Good Hope.

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